Report.

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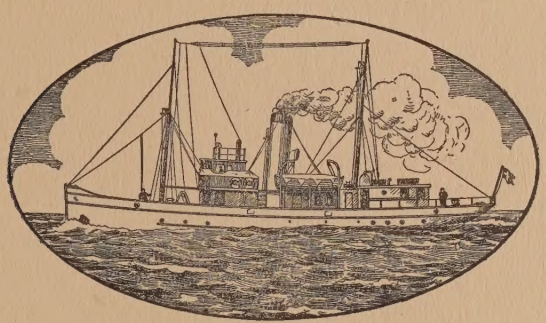
Report

of

The Danish Biological Station

to

The Ministry of Agriculture and Fisheries



XLV.

1940.

By

H. Blegvad, Ph. D.
Director

Copenhagen. C. A. Reitzel.
1944.

The Reports from the Danish Biological Station (Nos. I—XXI) are published in the official Danish "Fiskeri-Beretning" for the years 1890—91 until 1912. After this year they appear as special publications. The Reports I—XXXII are edited by Dr. C. G. Joh. Petersen, the Reports XXXIII—XXXVI by Dr. A. C. Johansen and the later Reports by Dr. H. Blegvad.

I. *C. G. Joh. Petersen:* Fiskenes biologiske Forhold i Holbæk Fjord. (1890—91)*) 63 pp. 1 Chart. Out of print.

II. *Idem:* On the Eggs and Breeding of our Gobiidæ. (1891—92.) 9 pp. Two Plates. Out of print.

III. *Idem:* The Pelagic Life in Fænø Sound etc. (1892—93.) 38 pp. Tables. Out of print.

IV. *Idem:* On the Biology of our Flat-fishes and on the decrease of our Flat-fish Fisheries. (1893—94.) 146 pp. 2 Plates. 1 Chart. Many Tables. Out of print.

V. *Idem:* The common Eel (*Anguilla vulgaris* T.) gets a Particular Breeding-dress before its Emigration to the Sea. (1894—95.) 35 pp. With 2 Plates.
Etc. 64 pp. Out of print.

VI. *Idem:* The Yearly Immigration of young Plaice into the Limfjord etc. (1895—96). 48 pp. 1 Chart. 2 Tables. Out of print.

VII. *Idem:* Plankton-Studies in the Limfjord. 1897. 23 pp. 1 Map. 4 Tables. Out of print.

VIII. *Idem:* An Otter-Seine for the Exploration of Deeper-Seas. 1898. 24 pp. With 10 Figures. Out of print.

IX. *Idem:* Trawlings in the Skager Rack and the Northern Cattegat in 1897 and 98. 1899. 56 pp. With one Map. Out of print.

X. *Idem:* List of the "Aalerusestader" in Denmark etc. — Smaller Communications. 1899 and 1900. 37 pp.

XI. *Idem:* I. The Biology of the Cod in the Danish Seas. II. On other Codfishes in our Seas. III. Some General Observations on Protection, Legislation etc. IV. Alterations and Improvements on Otter-seines for Zoological Purposes. 1900 and 1901. 44 pp.

XII. *Idem:* I. Where, and under what Conditions, can the Eggs of Plaice be developed into Young Fish within the Skaw? II. On the Young Stages of the genus *Zeugopterus.* (With one Plate). III. Can we enter into Competition with the Foreign Steam-trawlers in our Seas outside the Danish Territorial Limit. 1902 and 1903. 33 pp.

XIII. *A. Otterstrøm:* Eggs and Young of Fishes in the Danish Waters. (Investigations during 1904 and earlier years.) 1903 and 1904. 85 pp.

XIV. I. *C. G. Joh. Petersen:* The Influence of Light on the Migrations of the Eel. II. *K. I. Gemzøe:* Age and Rate of Growth of the Eel. 1906. 39 pp.

XV. *Idem:* I. First Report on the Oysters and Oyster Fisheries in the Lim Fjord. (70 pp.) 1908.

XVI. *C. H. Ostenfeld:* On the Ecology and Distribution of the Grass Wrack (*Zostera marina*) in Danish Waters. With 9 figures. 1908. 62 pp.

XVII. *C. G. Joh. Petersen:* II. Second Report on the Oyster and Oyster Fisheries in the Lim Fjord. 1908. (24 pp).

XVIII. *C. G. Joh. Petersen:* I. The Yield of the Limfjord fisheries in recent years and the transplantation of Plaice in 1908. With 6 tables and 1 Chart. II. Biological investigations on the stock of Plaice in the Limfjord. With 3 Tables. III. The Yield of the Prawn fishery from 1885—1907 and its improvement by means of protection. With 3 Tables. 25 pp. 1909.

XIX. *Idem:* Some Experiments on the Possibility of combating the harmful Animals of the Fisheries, especially the Whelks in the Limfjord. 20 pp. 1911.

XX. *C. G. Joh. Petersen* og *P. Boysen Jensen:* Valuation of the Sea. I. Animal Life of the Sea-Bottom, its food and quantity. With 6 Tables, 3 Charts and 6 Plates. 81 pp. 1911.

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*) The figures in ( ) refer to the "Fiskeri-Beretning" for the years quoted.

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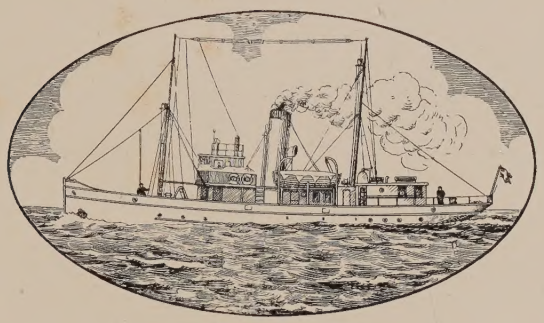

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C. G. Joh. Petersen. From a painting by Lilly Lundsteen, 1908.

THE DANISH BIOLOGICAL STATION THROUGH 50 YEARS

1889–1939

BY

H. BLEGVAD

COPENHAGEN

C. A. REITZELS FORLAG 1944

CONTENTS

page

Introduction 5
C. G. Joh. Petersen 5
The foundation of the Biological Station 6
Aim and material 6
The first years of the Station 9
Plaice investigations 12
Eel investigations 13
Continued plaice investigations 13
Other investigations.—New gears 15
The Station gets a steamer 16
The start of the international investigations of the sea 19
Fish eggs and youngs 22
Eel and light 23
Oyster investigations 25
The construction of the bottom sampler 26
The Petersen grab at work 29
The extension of the bottom investigations 29
The valuation of the sea 30
The animal communities of the sea-bottom 31
The nourishment of the bottom animals 32
The great war 1914—18. Investigations on the coastal fauna. Aquaria, bivalves and gobies ... 33
After war times. Changes in the stock of plaice in the Belt Sea 38

page

The plaice population of the Baltic 42
A. C. Johansen 46
Transplantations of plaice to the Belt Sea 47
Herring investigations 50
Investigations on pollution 51
Bottom animals and fish food; sprat, mackerel and flyings 52
The death of Dr. A. C. Johansen 53
The Station gets a new steam-ship, the "Biologen" 54
The pollution of the Sound 56
The disease of the eel-grass.—Investigations on the common dab 56
The results of the transplantations to the Belt Sea. —Pollutions in fresh waters 59
Examinations into the harmfulness of new gears.— Salmon and sea trout 61
Animal communities in the Dybsø Fjord.—Production of matter in the algae 64
The Biological Station is removed to the Charlottenlund Castle 65
The liberation of salmon and trout fry. Dab investigations 66
The races of plaice 67
1939. "Danmarks Akvarium". The war 67
Concluding remarks 68

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INTRODUCTION

In 1939 the Danish Biological Station had existed for 50 years. The history and the work of the Station during these years may be said to be the mirror of the history of the Danish fishery throughout the same period; the author of the present paper, therefore, has considered it likely that wider circles would take an interest in a more detailed account of the work of the Biological Station in the years between 1889 and 1939.

Throughout the first 37 years of its existence the name of the Biological Station was bound up in the name of our first fishery biologist, C. G. Joh. Petersen. Thanks to the energy and ability of this man, to his resourcefulness and his untiring interest in the many problems of the Danish fishery the Danish fishery biology for many years came to take a leading position in whole Europe and even throughout the world. It will therefore be natural to begin the present account with the life of this man and his work for the Biological Station.

C. G. JOH. PETERSEN

Carl Georg Johannes Petersen was born on October 24th, 1860 as the son of E. H. B. Petersen, a landed proprietor on Østrupgaard at the Odense Fjord. His father owned Vikkelsø in the Odense Fjord; on this islet with its rich bird-life the boy spent his childhood and first youth, and here the foundation was laid of the fervid interest in the living nature that filled the whole of his life. In 1879 he left the Aarhus Katedralskole to be entered as a student of zoology at the University of Copenhagen. Here he was a pupil of the famous Professor Japetus Steenstrup, whose distinguished personality exercised a great influence on him.

As early as 1881 he was attached to the Zoological Museum, from 1883 as an assistant. However, to a man with the disposition and personality of Joh. Petersen it soon became clear that a quiet life among preparations of dead animals in a museum was not in his line. He therefore at once accepted a proposition by Prof. Steenstrup that he should join in some cruises with the fishery inspection vessel "Hauch" in order to collect and examine marine animals in Danish waters.

The collections of bottom animals from the Kattegat made during the first 4 years, 1883—86, constitute the basis of the well-known work "Det videnskabelige Udbytte af Kanonbaaden "Hauch"s Togter" (The scientific results of the cruises of the gunboat "Hauch"). It appeared in 1893 under the editorship of C. G. Joh. Petersen and is a standard work, which in the years to come was the main source of our knowledge of the occurrence and distribution of the bottom animals in Danish waters. In works of this kind the zoologists of that time mostly confined themselves to bring a list of the species and the localities in which the animals had been found, but in the said paper Petersen tries to find the connexion between the distribution of the individual animal species and the natural conditions of the water in question: nature of bottom, depth, temperature and salinity. Among other things he shows that the number of species sinks towards the Baltic, a fact which he connects with the decreasing salinity; but he also shows that this decrease is more particularly true of the southern species while the northern species as a rule advance further towards the Baltic.

Also in his thesis for the doctorate, which was written in 1888 and was based on part of the material

from the "Hauch", C. G. Joh. Petersen enters upon investigations of a similar kind. In comparing the distribution of various species of gastropods and bivalves he shows that in the stone age the inner Danish waters had both a higher salinity and temperature than at the present time, which accounts for the fact that in the stone age the oyster was common all down to Funen and Seeland whereas nowadays—outside the North Sea—it will only thrive in the Limfjord and the northern Kattegat.

Already at that time Dr. Petersen, then only 29 years old, had carried out so important works of fishery biology, that it was quite natural that he of all men should become director of the new institution. This *i. a.* appears from his account on the practical-scientific investigations made by him in Danish waters down to 1888. This account was printed in the "Fiskeri-Beretning for Finantsaaret 1888—89" (Fishery Report for the Financial Year 1888—89). After having mentioned the systematic investigation of the bottom fauna of the Kattegat from the "Hauch" in 1883—86 and a few papers on fish from his hand, he gives an account of the fishery investigations made by him in 1887—88, to a great extent from the gunboat "Hauch". Besides his finding of the eggs and fry of our most important fishes at a time when almost nothing was known about these things and his constructing of new gears in which to catch them, he reports that he has invented the marking of living plaice with a brass mark, so that he was able to study their migrations, about $^1/_3$ of the fish thus liberated having been recaptured by the fishermen. The great importance of this marking method in later time is well-known to all students of fishery biology. This method is now used all over the world, so that the mere invention of this method would have been enough to make the name of Dr. Petersen go down to posterity.

Fig. 1. The birthplace of C. G. Joh. Petersen on Vikkelsø in the Odense Fjord.

THE FOUNDATION OF THE BIOLOGICAL STATION

The cruises with the "Hauch" had gradually increased the interest of the young undergraduate Petersen in the fishery biology. In his small paper on "The Work of the Biological Station from 1889—1914" (Rep. Dan. Biol. Stat. 22, 1914) he says himself that this was caused by intercourse with the fishermen and observation of the fishery. There is hardly any doubt, however, that the then Chief of the "Hauch", Lieutenant (later Captain) C. Fr. Drechsel (Figure 3) through his well-known interest in the Danish fishery also had a great influence upon the young man, and it was on the initiative and under the co-operation of Captain Drechsel, who had in the meantime become a fishery adviser, that The Danish Biological Station was founded in the year 1889 with Dr. Petersen as director.

AIM AND MATERIAL

In the "Instruction to the Director of the Biological Station", which was drawn up by the Board of the Interior and is found in print in the "Fishery Report for the Financial Year 1889—90", § 1 says, "The aim of the Biological Station will be to provide information on all such conditions within the natural science as may be of importance for the advancement of the practical fishery and serve to clear up questions concerning the fishery legislation". The material of the Station consisted of a cast transport vessel from the navy, which by a shipbuilder in Odense in the winter of 1889—90 was reconstructed into a laboratory under the supervision of Dr. Petersen. The excellent way in which this was done appears from the fact that the transport down to the winter of 1939—40 was used—and gave every satisfaction—as a laboratory and working room. In the "Fishery Report for the Financial Year 1888—89" is found a plan (reproduced here as Figure 4) showing the accomodation of the transport. It will be seen that

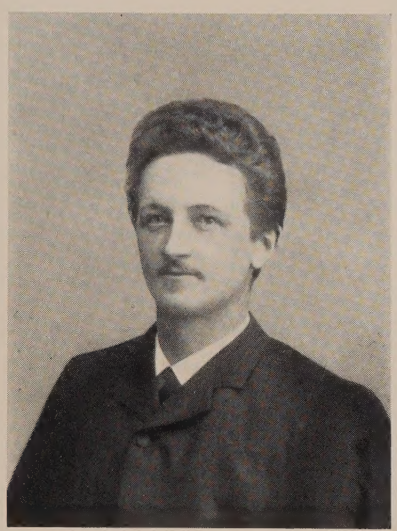


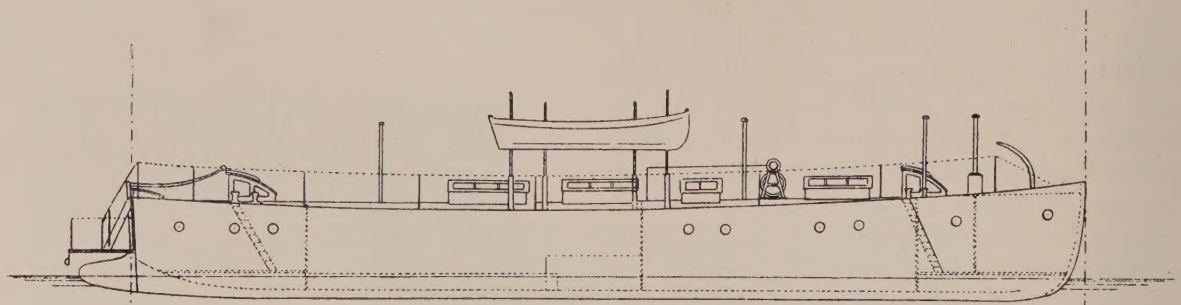
Fig. 2. C. G. Joh. Petersen when young.

besides 2 wells (b in Fig. 4) in which living fish could be kept there was a big room (F) with 6 salt water basins (a in the Figure), upon which were placed tanks and hatching apparatuses to be used for the hatching of fish eggs, etc. Besides the transport, which—generally for one summer at a time—was anchored in the water to be more closely examined, the Station had for its use a small, open petrol boat and an open sailing boat. Furthermore, excursions were often made with the gunboat "Hauch", which in most cases also towed the transport from one locality to another.

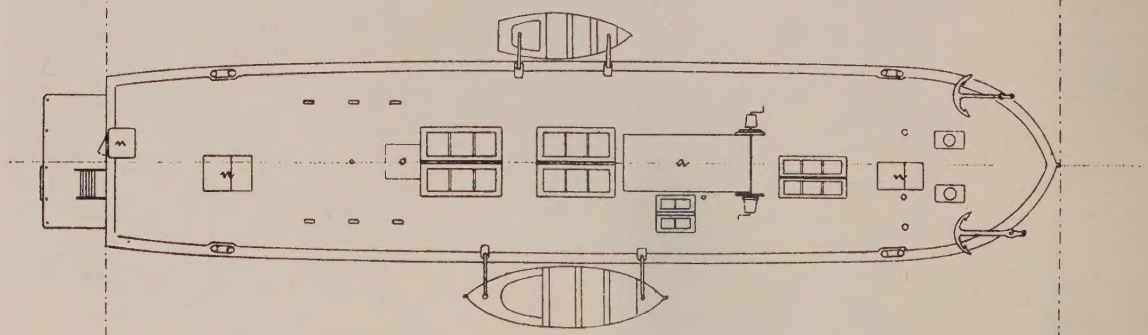
It appears from the instruction that a certain

Fig. 3. C. F. Drechsel. From painting.

collaboration between the University and the Biological Station was predetermined, § 9 saying, "When, by the arrangement of the Board of Education and the permission of the Board of the Interior, scientists or students are sent to the Station for education, he (*i. e.* the director) is expected to assist them in any way compatible with the works of the Station, and he is authorized to give such assistance to the Zoological Museum as conditions will permit". This collaboration has been kept up to the present date, the teachers and the students of the University having always been wellcomed for studies onboard. Moreover it appears from the first journal of the Biological Station that in 1890 there was a regular course onboard; teachers were the zoologists Dr. R. S. Bergh and Dr. (later Professor) H. F. Jungersen together with the botanist Dr. (later Professor) L. Kolderup Rosenvinge. Among the pupils were the candd. mag. H. Posselt and A. Stockmarr together with the studd. mag. I. A. Bøving Petersen, Adolf Jensen (later Professor of Zoology at the University) and C. Wesenberg-Lund (also later Professor at the University). The following



Deck plan.



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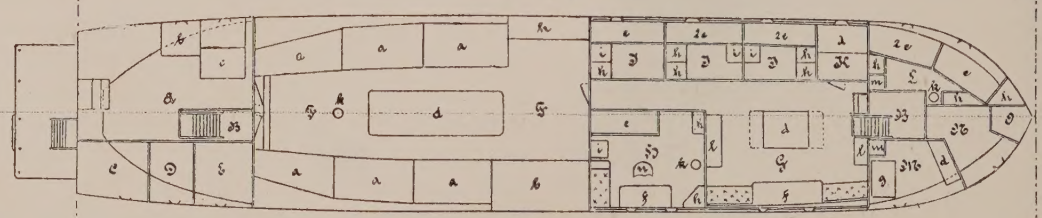

a. salt water tank.
b. well.
c. sink.
d. table.
e. cot.
f. writing table.
g. galley.
h. cupboard.
i. wash-stand.
k. stove.
l. book-case.
m. chain-locker.
n. hatch to compartment below.
o. pump.
A. room for sorting fish.
B. corridor.
C. crews' toilet.
D. officers' toilet.
E. for water-proof clothes.
F. laboratory.
G. cabin.
H. cabin of director of research.
I. ,, of assistants.
K. steerage.
L. the forecastle.
M. galley.
N. store-room.
O. ice-box.

Fig. 4. Plan showing the accomodation of the transport.

journals tell of similar courses at the Biological Station in the following three years. When later on a "marine-biological course" was made obligatory to the students of natural history, it took place without connexion with the Biological Station. This course is now held regularly every year, generally at Frederikshavn, and it may be added that the Biological Station, when an occasion offers, often arranges an excursion with the steamer of the Station for the attendants of the course.

THE FIRST YEARS OF THE STATION

On March 22nd, 1890 the transport was towed from Odense to the Holbæk Fjord where it stayed until Nov. 4th of the same year, when it was towed to Copenhagen for laying up. During this first summer Dr. Petersen studied the animal life of the Holbæk Fjord, on which he published his first "Report from the Danish Biological Station". These "Reports", which in the following years became an imposing series of valuable publications, the greater part of them written by Dr. Petersen himself, were printed in the annual "Fishery Reports" until 1908. From the year 1899 they were printed, too, as separate publications. The first report of the Biological Station has the title "Fiskenes biologiske Forhold i Holbæk Fjord" (The biological conditions of the fishes of the Holbæk Fjord), and in this paper Dr. Petersen gives a statement of both the lower animal life and the fishes of the fjord. He also describes the fishery, about which—as may be seen from the journal—he has constantly gathered information from the local fishermen. However, the principal news of the paper is that Dr. Petersen here advances the first results of a method invented by him for the determination of the age of fish of the first two or three year-classes, *viz.* the measuring method (Figure 5). In measuring a lot of small fish he saw that they grouped in certain length measures, from which he naturally concluded that they must be the mean sizes of the different year-classes, because the fishes in question breed within a certain, comparatively limited period, so that the young, growing-up fish will show approximately the same increase in length, at any rate during the first years. This method has been of very great importance in the fishery biology.

Already in this first report from the Biological Station Dr. Petersen advances the opinion that the eel must be breeding in the large, open seas because

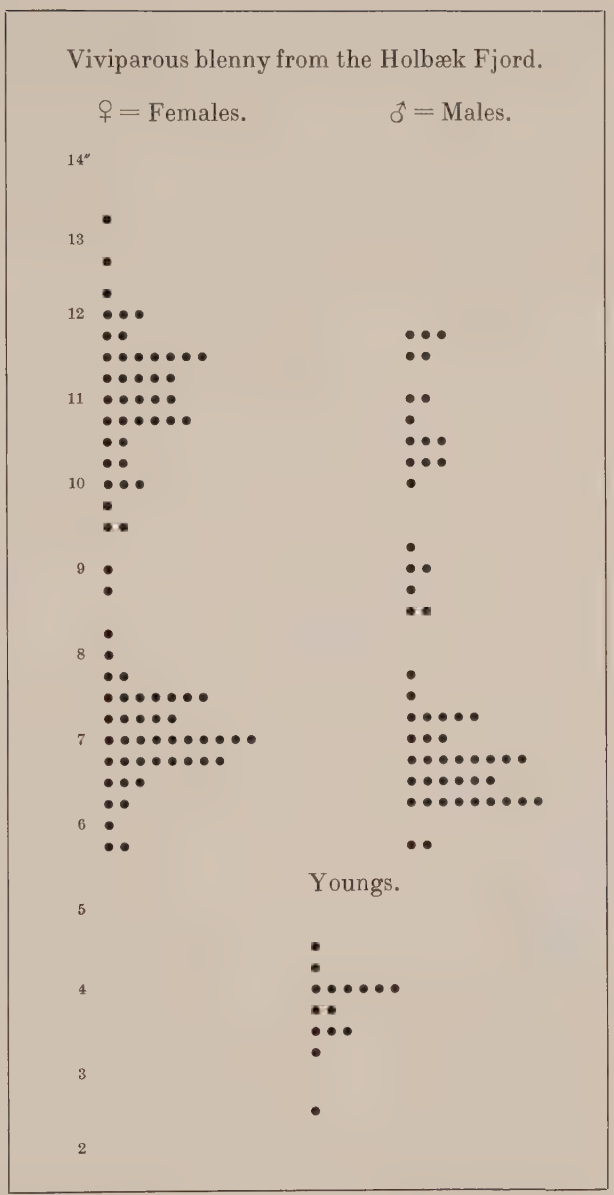

Fig. 5. Measurings of viviparous blenny from the Holbæk Fjord.

mature eggs or tiny fry are never found in our waters.

In order to fully understand the importance of these investigations we must remember that at the time when the Station was founded, it was generally supposed that our food fishes spawn in small fjords and inlets, so that it was particularly desirable to protect these waters. Accordingly, the Fisheries Act of 1888 "locked" many of these small waters to the fishery. This was no doubt the reason why the Station was

Fig. 6. The transport at Fænø Sund.

equipped with a material that could be used only for the investigation of such small waters. Now Dr. Petersen showed that our principal food fishes: flatfish, cod and eel all spawn in the open sea, and as a consequence of this these "locked waters" gradually disappeared from the fisheries legislation.

Of prominent visitors onboard in 1890 the journal gives the names of the Home Minister, the Minister of Naval Affairs, Prof. Lütken, and Prof. Flanault from France. Civ. Eng. Gudme seems for some time to have acted as an assistant.

On April 1st, 1891 the transport was towed from Copenhagen to Fænø Sund, where it anchored for the summer. This locality was also chosen for a working place during the investigations of the next summer. In the winter 1891—92 the transport had been laid up at Kolding. As a result of the investigations of these two summers appeared Report 2: "On the Eggs and Breeding of our Gobiidæ" (1892) and Report 3: "The Pelagic life in Fænø Sund etc." (1893). In the former report are described eggs and fry of our 4 common goby species; the latter tells about the fish eggs and youngs that had been observed in the Lesser Belt in 1891 and 1892, the lower animal life, the biology of our most common fishes and the fishery at Fænø and in the neighbouring waters. In Dr. Petersen's characteristic, often somewhat excursive way of statement many new and original thoughts are advanced here. He demonstrates that the life of the fifteen-spined stickle-back lasts only one year, that the youngs of the common dab contrarily to those of the plaice and the flounder grow up in deeper water, and he recommends a protection of the yellow eel, but not of the silver eel, by a minimum size-limit; he does not consider it necessary to protect the common dab in this way. While Report 1 was only printed in Danish, these two reports together with all the following ones also appeared in the English language.

The journal of 1891 mentions the first visit by Th. Mortensen, who later on became so famous as a zoologist and traveller, and who in the years

to come had much intercourse with the Biological Station. Visits by Prof. Lütken, Dr. Boas, Dr. Kolderup Rosenvinge and Dr. Wesenberg-Lund are also mentioned, and it is seen that Grønvold, the draftsman, who later on was used so much by the British Museum of Natural History has been onboard in order to draw fish eggs and youngs. In 1892 "Old Johansen", Johannes Johansen (Høj), fisherman of Kerteminde, came onboard for the first time: later on he was to become one of the best helpers of the Station (see articles in "Dansk Fiskeritidende" No. 16, 1910 and No. 23, 1917). His son Carl was already onboard, and his son Niels is still in the service of the Station. It further appears from the journal that the Station was visited by Dr. Jungersen, Dr. Rosenvinge, Dr. Bergh, Theilman Friis, the dispensing chemist, Dr. Munthe of Uppsala and by 4 undergraduates.

For the rest it is typical of Dr. Petersen that while the principal work of 1891 and 92 were the investigations mentioned above, it appears from the journal (and to some degree from the reports) that he has also been busy with many other interesting things: experiments have been made with the preparation of fish nets, new gears have been tried and important observations made concerning the distribution of the animal life. To him who knows Dr. Petersen's pioneer work on the "Valuation of the Sea" 18 years later, it is interesting to read in the report of 1892 that already then his thoughts were engaged in the mapping of the bottom animals of the Danish waters: "——I have both at Holbæk and here in the Lesser Belt attached great importance to the exploration of the extent of the various regions or zones of the seas; for the occurrence of the fish is to a very high degree dependent on them, and it is my hope at some future period to be able to map down all these regions throughout

Fig. 7. Scientists at work in the transport, 1891.
From the left: J. P. J. Ravn, R. S. Bergh, Bay, Posselt, person unknown, C. G. Joh. Petersen, Wesenberg-Lund.
From "Nordlyset" 1891.

all the Danish seas. Such a map will explain much about the different importance of the fisheries at the various places, explain for instance, why at certain parts the plaice fishery, at others the eel fishery, is of such a different value.—When we have drawn such a map, it will show us many things, with respect to what fisheries we may carry on at the various places as also to the economical importance, greater or smaller, which these may be supposed to get. In other words: we shall then have a "valuation" of our seas."

mer were carried out. Up to this time the Station had had only smaller sailing boats and a small "naphtha boat" to use, but now it got a decked boat "Makrelen", which was able to haul larger seines (Figure 8).

PLAICE INVESTIGATIONS

Report No. 4 of the Biological Station for the year 1893 (which was printed in 1894) bears the suggestive title "On the Biology of our Flat-Fishes and on the Decrease of our Flat-Fish fisheries with some ob-

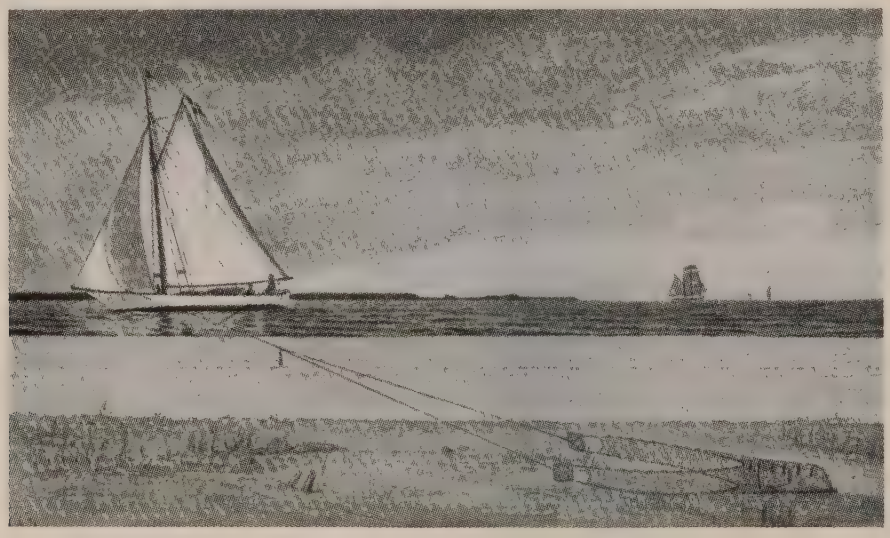

Fig. 8. "Makrelen" (the "Mackerel"), the decked boat of the Biological Station towing an otter trawl. From Report 8 of the Biological Station, 1898.

Also the influence of the cold on the animal life in winter was studied, and Dr. Petersen showed that the temperature in the soft muddy bottom of our fjords retains a height of 6—7° C. even if the temperature of the water in winter sinks below 0°. This is the reason why the eel and various other animals in winter bury themselves in the sea bottom, and Dr. Petersen is right in emphasizing that "——the eel-spear, which just at these places cuts through the bottom of our fjords everywhere, will bring death and destruction to a great number of animals, a destruction felt much more than that caused by certain seines in summer-time."

In the winter of 1892/93 the transport was laid up at Thurø. In April 1893 it was towed to Kerteminde Fjord where the investigations of the summer were carried out. Up to this time the Station had had only smaller sailing boats and a small "naphtha boat" to use, but now it got a decked boat "Makrelen", which was able to haul larger seines (Figure 8).

servations showing how to remedy the latter and promote the Flat-fish Fisheries in our seas East of the Skaw". In this paper Dr. Petersen shows that the intense fishing in the Kattegat has reduced the stocks of flat-fish, especially the stock of plaice, to such a degree, that their yields decrease, so that measures should be taken against this calamity. He further points out that a minimum size-limit and not regulations on mesh-width should be used to this end. He therefore suggests that the minimum size of 8 Dan. inches between snout and root of tail (the measure then in force) should be gradually raised to 8—9″ S. of Hjælmen—Sjællands Odde and to 10—12″ in the Kattegat.

It must be remembered that the extensive cutter fishery in the Kattegat rose enormously in the eighties and the beginning of the nineties of the last

century; but the heavy catches taken in the beginning could not be maintained in the following years. Most of the fishermen considered this a passing phenomenon and thought that the richness in fish would reappear. Already then, however, Dr. Petersen felt positive that the decrease of the stock would continue unless proper measures were taken against it because it was caused by the intense fishing, and he therefore proposed to protect the small fish by a minimum size-limit in order to get the highest possible yield out of the stock. It is worth noting that he proposed neither a reduction of the fishery itself nor so high a minimum size as was considered necessary by foreign, especially English fishery biologists, who desired such a minimum size-limit (the so-called "biological minimum size"), that all plaice were sure to get the chance of spawning at least once before they were captured because a lack of fry was foreseen (the propagation-theory). Against this view Dr. Petersen maintained that at any rate to begin with we need not apprehend any lack of young fish; it was only necessary to see that the fish were not captured until they had attained a profitable size (the "growth-theory"). The 46 years that have passed since Dr. Petersen advanced this opinion have fully shown that he was right: the "growth-theory" has now completely got the better of the "propagation-theory", both with regard to our flat-fishes and to our other salt water fishes.

The same paper brings a description and illustrations of the youngs of our common flat-fishes, which at that time was of considerable scientific and practical interest. It finally contains a report on the marking of 1,000 plaice in the Limfjord.

The journal of the Station for 1893 tells us that the following persons have been staying at the Station in this year for the sake of study: stud. mag. Bay, stud. Th. Mortensen, Dr. H. Jungersen, Dr. Kolderup Rosenvinge with 4 undergraduates, among whom was Bj. Sæmundsen, later on a well-known zoologist of Iceland, together with Mr. Sandemann from Scotland.

EEL INVESTIGATIONS

Already in October 1893 the transport had been towed from Kerteminde to Stege where it remained until it was taken to Frederikssund in the middle of May, 1894. In 1895 it was removed to Nykøbing Mors. Cand. Th. Mortensen is seen from the journal to have acted as an assistant onboard in these years.—The biology of the eel had already been studied by Dr. Petersen for some years. He had been keeping "yellow" eel in fish ponds and had seen them grow "silvery" in the course of a few weeks though these two sorts of eel had formerly by many zoologists been considered two different species. At Frederikssund he now studied all the eel he could procure, and the results of his studies

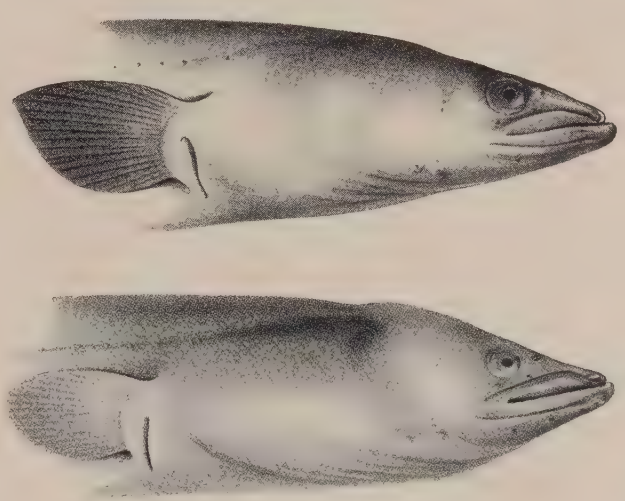

Fig. 9. A broad-headed yellow eeel and a broad-headed silvery eel. From Dr. Petersen's treatise in Report 5 of the Biological Station, 1894.

were embodied in the paper "The common Eel gets a particular breeding-dress before its emigration to the sea. The bearings of this fact on the classification and on the practical eel-fisheries". It was printed in Report 5 of the Station together with a few other small papers, partly by Dr. Petersen on the fishery at Stege and at Frederikssund and on markings of plaice, partly by Th. Mortensen: "Continued researches on the occurrence of the fry of Plaice in the Baltic Sea, in 1894 and 95."

The title of the paper on the eel in fact indicates its contents. Dr. Petersen shows that the yellow eel must be the young stages while the silvery ones are the grown-up individuals, which leave our waters in order to spawn in the open seas. All the silvery eel should therefore be captured before they leave. The spawning place of the eel was as yet unknown, but Dr. Petersen was quite right in supposing that the eel could not breed in our waters because eel

with fully developed eggs in their ovaries had not yet been observed, neither had young eel of less than 6 cm. in length. Just beforehand the Italians Grassi and Calandruccio had published their discovery of the fact that the curious lanceolate and transparent fish that had got the name of *Leptocephalus brevirostris* must be the young of the common eel. The eel must then be supposed to lay pelagic eggs in the sea where the young go through a meta-

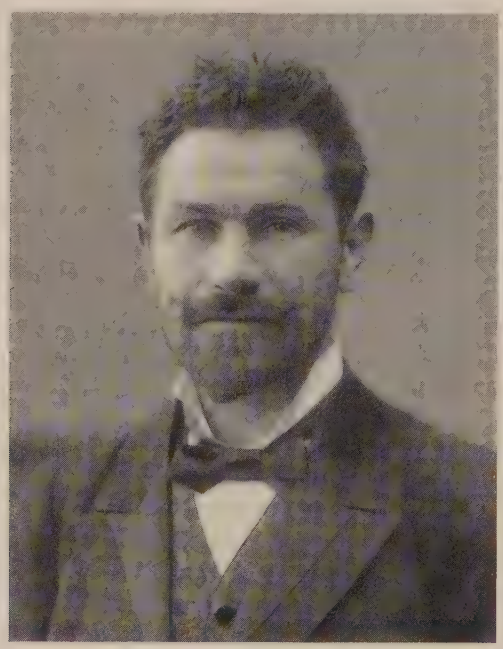

Fig. 10. Th. Mortensen.

morphosis, which is not concluded until they attain a length of 5 cm. Dr. Petersen quotes this result and apparently quite agrees with the Italians but hopes "soon to get further information as to their explanation of this fact". As known it was not until many years later that one of Dr. Petersen's own assistants, Dr. Johs. Schmidt, gave the "further information".

CONTINUED PLAICE INVESTIGATIONS

In his small paper on markings of plaice Dr. Petersen gives an account of the recaptures among 400 plaice marked and liberated in Mariagerfjord and 300 plaice liberated in Thisted Bredning. Only 15 specimens of the former group were reported to have been recaptured, 3 of them in the Kattegat; of the latter group, however, 77 were recaptured, nearly all of them in the Thisted Bredning. The buttons, like those mentioned in Report 4, were made of bone and fixed by means of a silver thread immediately below the dorsal, in other words the same method as is used at this day, only that the buttons are now made of ebonite.

Th. Mortensen's paper on the plaice of the Baltic deals with the question whether the plaice of the Baltic have immigrated from the Kattegat, as was supposed by Dr. Petersen. He arrives at the result that the facts seem to indicate that a considerable development of plaice in the Baltic takes place only in certain years, so that the greater part of the plaice population of the Baltic is probably recruited from the Kattegat.

As mentioned the transport both in 1895 and 1896 was anchored in the Nykøbing Fjord on Mors. A study of the journals of these years shows that many different subjects have engaged the keen and impressible mind of Dr. Petersen: the plankton fauna of the fjord, the bottom fauna and the plaice, cod, lobster and oyster fisheries.

For the catching of the plankton he imported new gears from Kiel, but for the examination of the bottom fauna he himself constructed an apparatus, which was able to take out a piece of the sea bottom with its whole contents of bottom animals. It was made by the local smith and consisted of a small iron box fixed at the end of a long stake, so that it could be pressed into the soft bottom; by means of a closing contrivance with a string-puller a piece of the sea bottom could be taken out. This apparatus, the "mud-spoon" or "snapping apparatus" (Fig. 23) was in fact the beginning of the "Petersen-Grab", which later on came to be known the world over.

The results of Dr. Petersen's plaice investigations were embodied in the well-known paper on "The yearly immigration of young plaice into the Limfjord from the German Sea.—The yearly fishing-up in the Fjord of the fish over the size limit. How to get a considerably increased income from this plaice fishery, which is now estimated at c. 300,000 Kroner a year, by the transplantation of young plaice". It was printed as Report 6 of the Biological Station. After having shown that the plaice does not spawn in the Limfjord he comments on the large number of small plaice found in the western part of the Limfjord and on the fact that their numbers decrease in an inward direction in the Fjord. In the inmost broad, the Thisted Bredning, practically no other

plaice were found than those which on private iniatiative, but with support from the Government, had been liberated there in the spring of 1895; this could be seen from the fact that every fifth plaice in the catches of the fishermen was "marked" with a hole in the fin. This marking had been carried out by the Fishery Inspection by direction of Dr. Petersen, and although only every seventh specimen of the 82,000 liberated in the Thisted Bredning had been marked in this way, the catches thus showed a higher percentage of marked fish. By means of the statistics and experimental fishings with the Danish seine it was shown that the western broad, the Nissum Bredning, sheltered at least 18 million plaice, or 4172 pieces per 1 acre, the Kaas Bredning at least 1683 pieces per 1 acre, the Venø Bugt 1329 pieces per 1 acre, but the Thisted Bredning only 31 plaice per 1 acre.

Dr. Petersen therefore concludes by suggesting an extended transplantation of plaice from the Nissum Bredning to the Thisted Bredning and Vilsund; the Biological Station was to take over the management of the transplantations during the first years, and the right to fish for plaice in the said waters was to be reserved for the neighbouring fishermen.

As known the last of these proposals could not be carried through because it conflicted with § 1 in the Fisheries Act, and another 12 years were to pass before the first large-scale transplantation was carried out in the spring of 1908. However, the small transplantations were continued with the support of the government.

For the rest the paper is very typical of Dr. Petersen. The account of the investigations is often rather superficial, and the style is excursive. But ever and again ingenious thoughts and new ideas and views turn up in the paper. It may for instance be mentioned that Dr. Petersen several times advances the view that the cause of the small size of the plaice in the western broads must be a local overpopulation, a view that later on proved to be correct. He also puts forward the idea that the coasts to which the floating eggs and tiny larvae of plaice are carried undoubtedly first and foremost are determined by the currents, or indirectly by the wind, and that current and wind in the North Sea have such a direction, that eggs and fry are principally carried eastwards towards the west coast of Jutland —a view that proved to be very important in the fishery biology at a much later date.

It appears from the journal of 1896 that Dr. Johan Hjort, the well-known Norwegian fishery biologist, visited Dr. Petersen onboard the transport at Nykøbing Mors on August 11th and took part in the investigations together with him. He came from Jena,

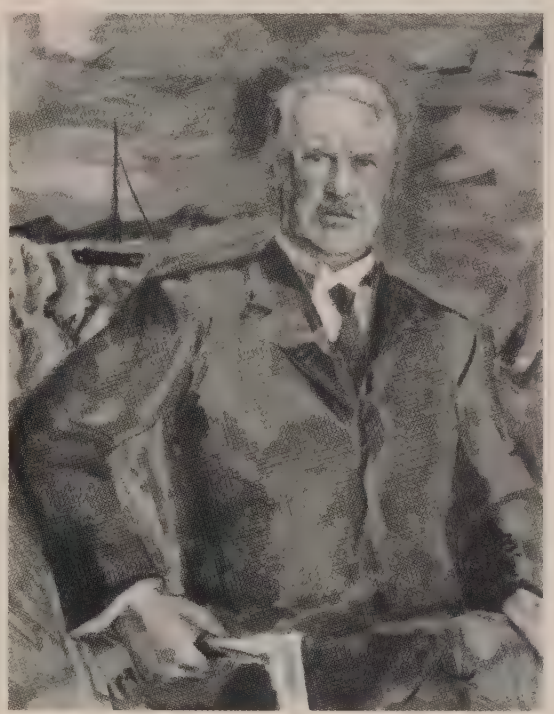

Fig. 11. Johan Hjort. From painting. 1938.

and this was undoubtedly the first meeting of these two prominent men, who thus began a fruitful collaboration.

OTHER INVESTIGATIONS
NEW GEARS

At the end of April, 1897 the transport was towed from Nykøbing Mors to Frederikshavn. The report of this year from the Biological Station, No. 7 in the series, contains a paper by Dr. Petersen on "Plankton studies in the Limfjord", in which it is shown that the Limfjord has its own diatom plankton, which is different from that of the Kattegat and the North Sea, and further that the plankton of the Limfjord is much richer than in these two waters.

Primarily, of course, the work at Frederikshavn dealt with the biology of the plaice: markings were made and race investigations carried out, etc. But besides this Dr. Petersen worked with the construc-

tion of new fishing gears, a wire net trawl, a "Danish trawl" and an otter-seine. The last-mentioned gear was described in Report No. 8 of the Biological Station, 1898 ("An Otter-Seine for the Exploration of Deeper Seas" by C. G. Joh. Petersen) and became an important gear in the investigations of the fishery biologists of other countries as well (see Figure 8). A contributory cause of this was that foreign scientists visited the Station and studied its working methods: the journal of 1897 tells us that so prominent scientists as Dr. Apstein of Kiel, Dr. as assistants in 1897. On April 12th we find the first mention of Chr. Christiansen, as a member of the crew. Later on he was to become captain of the steamer of the Station.

As a matter of curiosity may be mentioned that in the journal for June 23rd, 1897 Dr. Petersen says, "The price of plaice to-day is 29 Øre a pound (about 4 d.), more than ever in this town (Frederikshavn)".

Also in 1898 the transport was moored at Frederikshavn. Besides "Makrelen" also the steamer

Fig. 12. The "Sallingsund" in Fur Sund, 1900. C. H. Ostenfeld phot.

Hjort and Dr. Gran from Norway and Prof. Knipowitch from Russia paid shorter or longer visits onboard the transport. In this year Dr. Petersen himself visited Dr. O. Pettersson, the famous hydrographer of Holma in Sweden, and in August of the same year he went to Norway together with his skillful collaborator, the fisherman J. Johansen. Together with Dr. Hjort he carried out those fishing experiments in the Oslo Fjord, which gave rise to quite a new fishery, the norwegian prawn fishery. As we know this fishery later on grew very mportant, not only in Norway, but also in Sweden and—at last—in Denmark.

Cand. R. Hørring, the later ornithologist and Inspector at the Zoological Museum of Copenhagen and cand. Th. Mortensen are seen to have acted "Havørnen" from the Fishery Inspection and the "Guldborgsund" of the navy together with the hired towing boat "Expres" were used for the purpose of trying the new fishing gears in the Skagerak and the northern Kattegat. The results of these fishing experiments were published in the next report of the Station, No. 9 (1899): "Trawlings in the Skager Rack and the Northern Kattegat in 1897 and 98" by C. G. Joh. Petersen and J. Chr. L. Levinsen. This paper describes the animal life of the various areas of the said waters, thus contributing essentially to our knowledge of their fauna and adding no less than 40 species (7 of them fishes) to the Danish fauna.

Besides cand. Levinsen (alias J. Chr. Løfting, later on Inspector of the Fresh Water Fisheries) both cand. Hørring and cand. Kofoed, who afterwards

went to Bergen, for some time acted as assistants to Dr. Petersen. Of visitors the journal tells about cand. Knudsen (the later professor and well-known hydrographer Martin Knudsen), cand. Ostenfeld (the later professor of botany), Dr. Wesenberg-Lund, Dr. Hjort, Prof. O. Pettersson, Dr. Malm of Gothenburg, Prof. Henking, Prof. Vinciguerra of Rome and Dr. Arnold of St. Petersburgh. On May 25th we find the first mention of Niels Johansen, the son of Johs. Johansen, who later on was to succeed Christiansen as captain of the steamer of the Station, and who is still on the staff of the Biological Station.

THE STATION GETS A STEAMER

In the middle of September, 1898 the transport was towed by the "Guldborgsund" to Nyborg, its final mooring place until it was sold for breaking up 41 years later. In 1899 the small steamer "Sallingsund" was put at the disposal of the Station. It had belonged to the national railways and had worked the traffic between Glyngøre and Nykøbing Mors, but now it was rebuilt for the use of the Station with a commodious stern cabin for the director and his assistant, a forecastle for 6 men, and a small laboratory on the deck. During the following 33 years this small steamer, which was only 50 tons gross, gave every satisfaction. From March and far into October an energetic work was made from this steamer every year. The ship permitted the use of trawl, Danish seine, otter seine, dredge, etc., in short of all the gears used by a modern research vessel, though of course the trawls were of a moderate size. As a consequence of Dr. Petersen's great practical faculties and his interests in the details of the contrivances of the ship and the installation of the gears the steamer of the Biological Station, in spite of her small size, gradually came to be considered a model of a research vessel by foreign colleagues.

During the following time several new gears were tried from the "Sallingsund". On May 15th, 1899, for instance, the journal mentions the arrival of a German "eel-seine". Later on this gear was used extensively by the Station because it is easy to handle and it has a mesh size that retains also the young stages of fish, which as a rule escape through the wider mesh of the gears of the fishermen. The eel-seine is used by the Station even to this day, so that it is possible to compare the catches of former days with the present ones, a fact which is of course of very great importance in judging the increase or decrease of the fish populations throughout the years.

In the years 1899 and 1900 Dr. Petersen, assisted by the candd. Levinsen, Ostenfeld, Knut Dahl (the well-known salmon investigator of later times) and Kofoed (who went to Bergen later on), worked with plaice and cod and made a counting of the Danish eel-pots. In his later survey of the

Fig. 13. C. G. Joh. Petersen with "Boy" onboard the "Sallingsund", April 1900.
C. H. Ostenfeld phot.

work of the Biological Station from 1899—1914 (printed in Report 22 of the Biological Station, 1914) Dr. Petersen says, "In a country such as Denmark, where the fishing industry is carried on to such a degree of intensity, it is not to be expected that important new fisheries should often be discovered; the Station has, however, beyond all anticipation, succeeded in effecting something in this direction, in the year 1899—1900, when experiments with new apparatus were being made on board the "Sallingsund" with a view to discovering the most suitable form of implements for investigating the stock of fish. These experiments were com-

menced in the Great Belt, close to the Station, and it was soon noted that a surprisingly large amount of plaice were taken in the small seine nets, while the fishermen working the Belt were complaining of cutters immediately appeared on the scene with "Snurrevaad" (Danish seine), and made good catches."

This was the beginning of the rising seine fishery

Fig. 14. Fishing cutter from Frederikshavn fishing with Danish seine in the Great Belt. August 1900. C. H. Ostenfeld phot.

Fig. 15. At work with the eel-pots.
In the dingey from the left: "old" Johansen, Christiansen, Niels Johansen.
C. H. Ostenfeld phot.

the poor quantities of plaice caught by their gill nets; seine nets for plaice being then practically unknown in those localities. The big hauls made by the Station, especially south of Sprogø, gradually became noised abroad, and the news, briefly mentioned in a local paper (Nyborg Avis), reached among other places Frederikshavn, whereupon some large for plaice in the Belts. In the course of 12 years the profits of this fishery rose from 100,000 Kr. annually before 1899 to more than 1 million Kr. in 1912. As an instance of the quantities of plaice that could be taken in the Great Belt in 1899 may be quoted an entry in the journal of the Biological Station from Sep. 12th, 1899: "In the course of 36 hours Siegfred

from the cutter "Gertrud Marie" of Frederikshavn caught 750 scores of plaice, but many of them died for him, and the rest were sold in Copenhagen at a price of 2 Kr. per score".—An enormous thinning of the plaice population of this water was the consequence of the intense fishing. It appears from the journal of the Station that a small trawl in 1899 took about 300 plaice in one haul S. of Sprogø. 22 years later the same kind of gear brought out only 1—3 plaice per one haul in the same locality!

Report No. 10 (for the years 1899—1900) of the Biological Station appeared in 1901 and contains two papers by Dr. Petersen, partly a "List of the "Aalerusestader" in Denmark", partly a series of "Smaller Communications". This great work of counting and listing all Danish eel-pots was made in order to find out the place of origin of all the silvery eel that leave our waters in the autumn. Dr. Petersen himself writes that he was originally of opinion that the great majority of these fish would prove to originate from the Baltic but that he had had to give up this theory because the catches of the Sound must then have been much heavier than they turned out to be. He therefore arrives at the conclusion that most of the silvery eel taken in wheels in the autumn originate from our own waters. The end of the paper contains a series of practical hints and suggestions for the fishermen.

The "Smaller Communications" of the report deal with such varied subjects as the plaice of the Limfjord (with a renewed agitation for larger transplantations), the sharks of the Danish waters, the value of the common star-fish for manurial purposes, and the spawning places of the herring. They all give evidences of Dr. Petersen's alert and versatile interest in the various problems of the fishery.

THE START OF THE INTERNATIONAL INVESTIGATIONS OF THE SEA

Among the visitors at the Station the journal of 1899 mentions 5 Norwegians: Dr. Hjort, cand. Dahl (the well-known salmon investigator Knut Dahl), O. Nordgaard (Director of the Biological Station of Trondheim), Mr. Barclay from Haugesund and cand. Wollebæk. Of Danish names we find Dr. Mortensen, Dr. Steenstrup and cand. Ostenfeld; cand. Levinsen was Dr. Petersen's assistant. The preparations for the founding of the "International Council for the exploration of the sea" had been started by this time, a fact of which the journal reminds us in saying that Dr. Petersen in June, 1899 attended the international conference of fisheries in Stockholm, after which Dr. Hjort and the famous Sir John Murray from Scotland paid a visit of some days to Dr. Petersen onboard the "Sallingsund" in the Limfjord. About one month later Dr. Petersen together with Dr. Hjort paid a return visit in Scotland and made a cruise of some

Fig. 16. C. H. Ostenfeld.

days with the research vessel "The Garland". Also in the following year Dr. Petersen attended the international congress at Copenhagen. In this year cand. Ostenfeld and cand. Kofoed acted as his assistants.

In the spring of 1901 Dr. Petersen attended the international congress in Christiania where the forms of the magnificent collaboration of the coming years under the auspices of the "International Council for the exploration of the sea" were planned. Three other attendants, Dr. O. Nordquist, Finland, Dr. N. Trybom, Sweden and Mr. Garstang, England went back together with Dr. Petersen and for some days made cruises with the "Sallingsund" in the Great Belt. Later in the year the Norwegian research vessel "Michael Sars" with Dr. Hjort paid a visit at Frederikshavn and the Skaw. Of other visitors the journal mentions Dr. Schiementz of

Müggelsee ("on board to learn the use of certain gears"), Dr. Rosenvinge and Dr. Ostenfeld, who commenced his *Zostera* (eel-grass) investigations with a 3 weeks' cruise with the "Sallingsund" in the summer of 1901. As assistants onboard were acting partly Dr. Mortensen, partly Mag. Johs. Schmidt,

Fig. 17. Johs. Schmidt. Early picture.

the famous eel investigator of later years. It further appears from the journal that the "Sallingsund" in 1901 got another engine (viz. that of the "Hauch") and a new boiler.

Report 11 of the Biological Station (for the years 1900 and 1901) was printed in 1902 and contained a paper on "The Biology of the Cod in Danish Seas". Basing on the comparatively light catches of young cod of the first stages made by him in spite of an eager search with different gears Dr. Petersen here advances the idea that the tiny fry of the cod is carried out of our waters by the marine currents while in return another fry is carried into our waters from the North Sea in August—October. Later investigations have shown that this is hardly correct: the cod fry must be supposed to develop in our own waters. The reason of Dr. Petersen's mistake is undoubtedly a double one: in the first place the youngest stages of cod fry are difficult to capture because the tiny fry spread over so vast areas and easily go through the meshes of the gears ordinarily applied; in the second place the years 1900 and 1901 were "poor spawning years", that is to say that comparatively few young cod came to be developed in these years.

The same report also contains 3 smaller papers: "On other Codfishes in our Seas", giving our knowledge at that time of the biology of the other cod-

fishes, "Some General Observations on Protection, Legislation etc.", in which Dr. Petersen explains the reason why the legislation should repeal the prohibition of using trailing gears, especially in the "locked waters", because our principal food fishes do not spawn in the fjords but in the open sea and because the seines cannot be supposed the destroy the food animals of the fishes, a common belief of former times. He recommends an appropriate protection by means of a minimum size-limit of a number of fishes and emphasizes that also the prawn undoubtedly needs a protection, referring to Dr. Mortensen's paper on the biology of the prawn in the 1897 publication of "Dansk Fiskeriforening". In "Alterations and Improvements on Otter-seines for Zoological Purposes" Dr. Petersen finally gives a number of advice concerning the practical use of these seines.

Fig. 18. The transport and the "Sallingsund" anchored under Fænø early in 1902. Johs. Schmidt phot.

In 1902 the "International Council for the exploration of the sea" was formed at the meeting in Copenhagen on 22. July. The Danish Government was represented by Capt. Drechsel and Docent Martin Knudsen while Dr. Petersen and Dr. Ostenfeld attended the meeting as experts. It appears from the first report on the meetings of the council (Rapp. & Proc.-Verb. des Réunions Vol. 1, 1903) that Dr. Petersen became the leader of all works of fishery biology in Denmark; S/S "Thor" is reported to be at disposal for the work in the North Sea and the Northern Atlantic, the Biological Station and S/S "Sallingsund" for the Danish waters. As the assistants of Dr. Petersen are mentioned Mag. sc. Johs. Schmidt and Mag. sc. A. C. Johansen, and it also appears from the journal of the Biological Station that they worked as assistants onboard the "Sallingsund" in the summer of 1902. Of visitors the journal mentions Prof. Jungersen, Dr. Steenstrup, Doc. M. Knudsen, A. Otterstrøm and Frits Johansen. In the spring of 1902 the transport was anchored at Fænø for $2^1/_2$ months, principally for investigations on the occurrence of fish fry. The work during the rest of the year to a great extent consisted in a clearing up of the distribution of the plaice fry at the Danish coasts.

In 1903 Mag. A. Otterstrøm became assistant onboard. The journal says that much of the work of this year consisted in fishing the waters between the Limfjord and Bornholm, and a special study was devoted to the biology of the flat-fishes, *i. a.* with respect to the question about race. At the beginning of June Dr. Hoek, the general secretary of the International Council paid a visit onboard. At the end of the same month the "Sallingsund" paid a visit at Kiel where the well-known sea investigators Prof. Hensen, Prof. Brandt, Dr. Reibisch, Dr. Apstein and Dr. Immermann were onboard. In July the "Sallingsund" was at Stralsund where Dr. Sandman from Finland was onboard. In August he paid another visit together with Dr. Hjort.

Fig. 19. Andreas Otterstrøm.

Report 12 of the Biological Station for the years 1902 and 1903 (printed 1904) contains 3 papers by Dr. Petersen. In the first of these papers ("Where, and under what Conditions, can the Eggs of Plaice be developed into Young Fish within the Skaw?") attention is called to the fact that the two youngest year-classes of the plaice, especially the youngest one (the 0-group) occur very scantily in the Baltic, for in spite of a very eager search it had been possible to find only quite a few individuals during the investigations carried out down to that time. The large stock of plaice found in the Baltic can therefore be supposed to be recruited in three ways only, (1) extremely slowly by a very small annual increase, (2) by a rapid increase of solitary years in which the hydrographic conditions must be very different, so that the fry occur in large quantities, or (3) by immigration (p. 14). Dr. Petersen considers the last possibility the most likely, but he concludes by

putting up a program of future international investigations for the purpose of elucidating this question.

The second paper "On the Young Stages of the genus *Zeugopterus*" brings a description and illustrations of the youngs in question, to some extent based on material brought home from the Atlantic by the research vessel "Thor". In the third paper "Can we enter into Competition with the Foreign Steam-trawlers in our Seas outside the Danish Territorial Limit?" Dr. Petersen proposes to attempt a trawl fishery—that is to say beside the common cutter fishery—in our open waters.

FISH EGGS AND YOUNGS

In 1904 the investigations principally dealt with the distribution of fish eggs and youngs in the different waters between the Skaw and Bornholm. Furthermore, experiments were made with various gears, *i. a.* a herring trawl. Also in this year A. Otterstrøm was the assistant of the Station. The journal says that he read informatory papers to the fishermen of different harbours. Among the visitors the journal mentions Mag. Gemzøe, Dr. W. Garstang, the English fishery biologist (who later on was the host of Dr. Petersen and A. Otterstrøm onboard the "Huxley" on a trip to Helgoland), the undergraduate C. V. Otterstrøm (brother of A. Otterstrøm and later fishery biologist at the department of the Biological Station for fresh water fisheries), Dr. Rosenvinge, cand. A. Brinchmann (later Professor at Bergen), Prof. Jungersen, Prof. O. Pettersson and Son (during a visit by the "Sallingsund" in Gullmarsfjorden), Prof. Gauss from Hungaria and Dr. Hjort.

Report 13 of the Biological Station for the years 1903 and 1904 (printed in 1906) contains a paper by A. Otterstrøm, "Eggs and Young of Fishes in the Danish Waters". It is a survey of investigations carried out from the Biological Station in 1904 and earlier years, supplemented with some few observations from the research vessel "Thor" by A. C. Johansen. A thorough description is given of where and at which season eggs and youngs of each species of fish have been found, and the whole paper may be considered a summary of our knowledge at the time of eggs and youngs of fish in Danish waters.

EEL AND LIGHT

From the journal of the Station for the year 1905 it is seen that the work of the former half of this year was principally devoted to searches for fish fry; besides this markings of cod were carried out, and the new method of determining the age of the fish by means of the growth zones of the otoliths, which later on became so important in the investigations of the fishery biology, was introduced in this year after a visit by Prof. Reibisch of Kiel. During the latter half of the year investigations involved oyster and eel. In 1905 Dr. Petersen had succeeded Etatsraad Jonas Collin as adviser of the Ministry of Agriculture concerning oyster cultivation. A more interesting question, however, was the eel investigations, during which experiments were made for the purpose of stopping the migration of the silvery eel by means of light. After some preliminary attempts in "Kilen" at Struer a large-scale experiment to stop the migration of the eel was carried out in the Lesser Belt at Fænø in the autumn of 1905. A cable with 50 electric bulbs was placed across the Belt between Fænø and Funen where a wheel was placed near the shore with no bulbs near it. The light was meant to drive the migrating eel towards Funen, so that they went into the wheel.

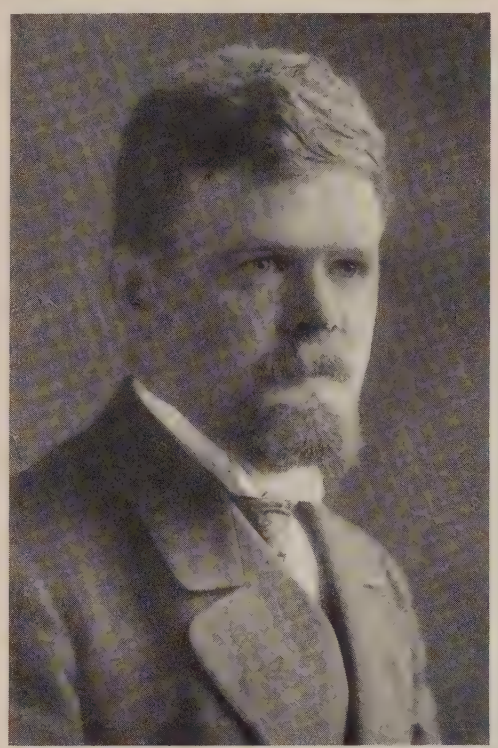

Fig. 20. Chr. D. Lunn.

The experiment met with no success. In Report 14 for the year 1906 ("The Influence of Light on the Migrations of the Eel") Dr. Petersen says that this experiment gave no result mainly because easterly winds carried the eel between Fænø and Jutland. To the present author Dr. Petersen explained that the local fishermen north of the barrier appealed to

Fig. 21. K. J. Gemzøe.

the Ministry saying that the experiments damaged their livelihood and that this fact was the principal reason why he gave up this question after some time. There is no doubt that Dr. Petersen was right in supposing that the silvery eel avoid light, also artificial light, during their migrations, but the practical difficulties about the right way of making the most of this experiment are extremely great because the eel must not only be stopped, they must be captured as well.

Of visitors besides Dr. Reibisch the journal of 1905 mentions: Dr. O. Nordquist, Prof. F. Nansen, stud. med. O. Chievitz, cand. I. P. Jacobsen, the hydrographer, Prof. Jungersen and the present author who, as an undergraduate, during a fortnight's stay onboard the "Sallingsund" at the end of March and the beginning of April got a first glimpse of the methods of the fishery biology under the expert supervision of Dr. Petersen. At the end of April of the same year I joined in the cruise of the "Thor" on the Atlantic as the assistant of Dr. Johs. Schmidt.

It further appears from the journal that A. Otterstrøm left the Station by the end of July after he had been appointed superviser of the fisheries of Bornholm. As known it was Otterstrøm who established the first school for fishermen a few years later. In the beginning he hired a villa at Kerteminde, but later on the school got its own building at Snoghøj. Unfortunately, Otterstrøm had to give up the school after many years of assiduous work. He died in 1938 as a lecturer at Sønderborg.

The investigations on oyster and eel were continued in 1906, in which year cand. Chr. D. Lunn and cand. K. J. Gemzøe acted as assistants. The former in 1901 became leaseholder of the oyster fishery in the Limfjord, the latter in Report 14 of the Station wrote a paper on "Age and Rate of Growth of the Eel", in which, basing on a study of the growth zones in the scales of the eel, he demonstrates that it is possible by this means to learn the duration of the stay of the eel in Danish waters. He arrives at the conclusion that the males stay here for $4^1/_2$—8 years, the silvery females for $6^1/_2$—$12^1/_2$ years.

As a matter of fact the problems concerning the eel were discussed very much at that time. From the research vessel "Thor" Dr. Johs. Schmidt had in 1904 found the first eel larva in the Atlantic SW. of the Faroes. Both he and Dr. Petersen at once realized the importance of this event; the latter published the finding in "Meddelelser fra Kommissionen for Havundersøgelser", Ser. Fiskeri, Vol. 1, 1905, and during the following years it became one of the principal tasks of Johs. Schmidt to throw light on the mysteries connected with the breeding of the eel: in 1905 and 1906 he further found large quantities of eel larvae W. and SW. of Ireland. This was the beginning of the search for the spawning places of the eel; as known it was not until 16 years later that Johs. Schmidt by his investigations, which are now known all over the world, managed to establish the fact that all European eel breed in the deep Atlantic between the West Indies and the Bermudas.

OYSTER INVESTIGATIONS

In 1907 cand. mag. J. Nielsen, the hydrographer, was appointed assistant of the Station, but was succeeded in October by Dr. A. C. Johansen. The investigations of this year nearly exclusively dealt with the oyster, and in the Report of the Station for 1907, No. 15, Dr. Petersen summed up the results of his oyster investigations. The paper was called "Studies on the Oyster Fishery and the Oyster in the Limfjord", and here he shows that the protection established in 1886—90 on account of the decrease of the fishery during the previous years did not bring about any rise in the number of oyster caught. He further proposes that the minimum size-limit (8 cm) should be decreased and an intenser fishing started in order to secure a more rational exploitation of the whole stock. In a special section "On the Future" he advances the opinion that the government ought to take over the oyster fishery, so that it would be possible to gain experience of the best way in which to approach the matter. If, however, it was decided to lease out the fisheries again, more oyster than the usual 1 million pieces ought to be caught annually —he himself mentions 3—4 millions— and the oyster ought to become cheaper (the price was then 20 Danish Øre apiece).

The government chose the latter alternative. In accord with the wish of Dr. Petersen cand. Chr. D. Lunn became leaseholder of the oyster fisheries when the old contract expired in 1910: he had studied the question under the supervision of Dr. Petersen in 1906, and during his lease there was a very intensive oyster fishing with the dredging of several million pieces per year. As known the stock proved to decrease after some years, a fact that has been ascribed to the intense dredging. Later on, however, it became clear that nature (*i. a.* a series of cold summers) was more liable to be responsible for the infavorable development of the stock with the result that periods of decrease occurred as in the beginning of the eighties of the last century.

Of visitors onboard the journal of 1907 mentions only Dr. Brühl of Berlin.

Fig. 22. A. C. Johansen and J. N. Nielsen in the laboratory of the "Thor", about 1902.

THE CONSTRUCTING OF THE BOTTOM SAMPLER

In 1908 the present author became the assistant of Dr. Petersen with a relief by cand. Chr. D. Lunn only in the month of September. Investigations were pursued principally in the Limfjord, Isefjord and at Nyborg and were mostly devoted to the growth and

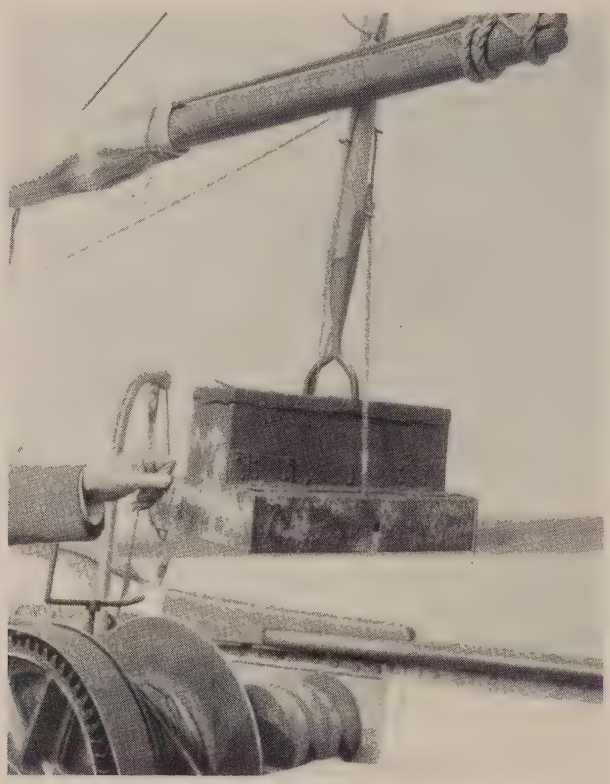

Fig. 23. The "mud-spoon".

the food of the flat-fish. Experiments with different gears were made onboard for the purpose of examining the amount of food on the bottom of the sea. At first we used the "mud spoon" (mentioned above), which Dr. Petersen had constructed in 1896, and by means of which we could take out small bottom samples in an iron box fixed at the end of a long stake and made to be opened and closed with a string puller. But the drawback of this apparatus was that the stake broke easily and, above all, that it could be used only at small depths, that is to say as far down as the stake would reach. Another apparatus had to be devised.

The first year of my assistantship to Dr. Petersen is still quite clear in my memory though I was then only 22. I had joined in Johs. Schmidt's cruises with the "Thor" on the Atlantic in 1905 and 1906 and in A. C. Johansen's investigations in Danish waters from the same vessel. There was much to learn from these two excellent scientists: I had had an insight in the deepsea fisheries of the English, Germans and French at Iceland and in their own waters; I had noticed the intensity and method of Johs. Schmidt's working with a full exploitation of the comparatively short time in which the "Thor" was at his disposal: fishing and working went on day and night whenever the weather was comparatively tolerable. And I had learned to know Dr. A. C. Johansen as an industrious, well-read and extremely interested fishery biologist, who had a most intimate knowledge of modern methods of investigation.

I now approached the man who was beyond challenge the leading personality in Danish fishery biology of the time. I had a certain feeling of uneasiness when I went onboard at Lemvig for the first time—on 4. April 1908. We were then present at the large transplantations of plaice that were carried out in this year on the initiative of Dr. Petersen, and before long the work became familiar to me. For also onboard the "Sallingsund" hard work was done. Ever since his cruises with the gun-boat "Hauch" Dr. Petersen bore the stamp of a naval officer. In spite of the small size of the boat he liked a tincture of military precision in the work. The crew carried uniforms of naval fashion; Dr. Petersen himself always went in double-breasted, blue jacket, and onboard he used the cap of the Royal Danish Yacht Club with emblem. But the small, well-constructed stern cabin was cosy, and Dr. Petersen was a great lover of good food and wines, so that we always had a first-rate cook. He used to be an excellent and cheerful host who spiced the meal with a great many anecdotes—all of which the assistant at last knew by heart. In the daily routine he was cool and formal, especially in front of strangers, and in spite of his great interest in the work of the fishermen he never became popular with them. Nevertheless he often spoke with the fishermen, both at sea and ashore, in order to seek information of this and that, and he knew and often visited the leading fishermen of the different localities.

Every night the captain came down into the cabin to get his orders for the next day. If nothing particular lay before, it was a standing rule that the

"Sallingsund" left the harbour or the anchorage at 6 o'clock sharp every morning.

Dr. Petersen rarely had a fixed programme for the work of the day. He gave his orders as the investigations went on, and nobody knew where we would end the day. Accordingly, the investigations often changed from one thing to another: I said above that the principal work of 1918 was investigations on growth and food of the flat-fish, but it should be added that we also examined several other things, for instance oyster, cod, eel, gastropods for poultry fodder, etc.

The boat was rarely moored for the night until 6 or 7 in the afternoon. There were no fixed summer holidays, and though as a rule no sailing was made with the steamer on sundays, there was mostly some thing or other to be examined from the sailing boat or some writing to be done. Dr. Petersen rarely went ashore unless he had a fixed aim, and he liked to anchor for the night even if we were immediately outside a harbour, so that he was certain that the assistant and the crew remained onboard. But there was much to learn from this resourceful and originative man! He had a rare gift of animating one's thoughts. The conversation at table, during the work and in the evening was always about the problems of fishery and the means to solve them. His ideas were manifold and multifarious—some of them good, some ingenious, but many impracticable and not very elaborate. However, this will always be the way of an active mind, and the value of the ingenious ideas will always outbalance the less elaborate ones. When an idea had been born, we at once started to carry it to effect: with his untiring energy Dr. Petersen either made the crew of the boat carry it out, or he applied to others for technical assistance.

This was also the case with the "mud-spoon". We knew that another construction was necessary for the work at greater depths, and gradually, after several solutions had been discussed, the idea was born of the "grab", this small gear that was to become so famous. I remember that I made the first draft of the construction on a slip of paper one night in the cabin of the "Sallingsund". With this draft Dr. Petersen went to his cousin Axel Møller, Civ. Eng. in the firm of Ludvigsen & Hermann and made him make the geometrical drawing. But it was not until 1909 that the real working with this gear began.

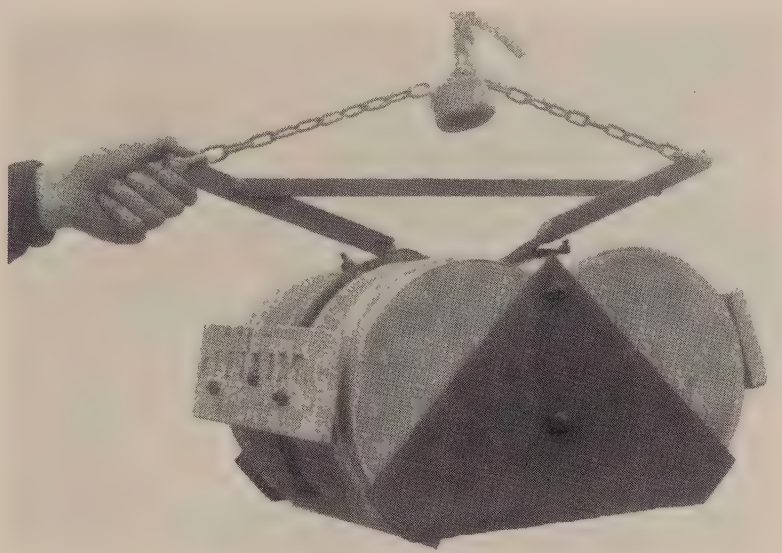

Fig. 24. The first bottom sampler. 1909—10.

In 1908 E. Saabye was attached to the Station as chief engineer and R. Rasmussen as stoker; both of them are still in the service of the Station.

Two reports, No.s 16 and 17 in the series, were published for the year 1908. One of them, called "On the Ecology and Distribution of the Grass Wrack (*Zostera marina*) in Danish Waters", was written by Dr. C. H. Ostenfeld and had for its motto a clause from Dr. Petersen's first report:

"This is undoubtedly the plant that to a great extent conditions the richness of fish in our coastal waters". This is well worth noting, for already at an early point of time Dr. Petersen emphasized the importance of the eel-grass for the nutrition of the fish, being a feeding and growing locality partly of the young cod, eel, flounder and other food fishes, partly of the small fish that serve as food of the food fishes. This is undoubtedly correct. We shall see later that during his investigations with the grab Dr. Petersen went a step further in his supposition that the importance of the eel-grass extended beyond the limits of the vegetations (in Danish waters at about 12 m depth) because the detached and decaying leaves serve as food for the animal life of the bare, deeper sea-floor, a view which has been criticized in recent times. However, it is clear that Dr. Petersen had set Dr. Ostenfeld the task of examining how many leaves were produced by every plant of eel-grass. In measuring the length of the leaves throughout the year Dr. Ostenfeld arrives at the conclusion that every plant has an annual production of 4—6 leaves. The paper further contains a survey of the distribution of the eel-grass, illustrated by maps.

Report No. 17 contains "Continued Studies on the Oyster Fishery and the Oyster of the Lim Fjord" and is the result of the oyster investigations of the last years in the Limfjord. The author estimates the number of oyster of more than 7 cm at about 90 millions, but of oyster above the then minimum size-limit at only 40 millions. He therefore once more suggests an intenser fishing.

In 1908 Prof. Kofoid of Berkeley, Cal., visited the Station for two days. In December the "Sallingsund" made a trip with the pupils of cand. A. Otterstrøm's school for fishermen at Kerteminde.

THE PETERSEN GRAB AT WORK

In the summer of 1909 cand. Sell for some periods acted as an assistant instead of the present author (who was reading up for his examination). The investigations principally dealt with the quantities of fish food on the bottom of the sea, for which purpose the newly-constructed bottom-sampler was used both in the Limfjord, at Nyborg, in the Odense Fjord and in other localities. At the same time Dr. Petersen studied the different layers of the bottom of the sea in order to find out what the bottom animals lived on. Small containers were deposited on the sea-floor in order to catch the fine "detritus" that sinks to the bottom and is spread again by stormy weather. By means of long tubes of glass samples of the sea-bottom were taken out, so that the different layers could be studied. But Dr. Petersen was engaged in many other things. He had seen the damage done to the plaice in the nets in the Limfjord by the gastropods *Buccinum undatum* and *Nassa reticulata*, especially in the Thisted Bredning, and he formed

Fig. 25. Plaice caught in net and covered with gastropods. From Report 19 of the Biological Station, 1911.

a scheme of trying to root them out by catching them in "Kuber" ("hive-traps"), a kind of wheels with enclosed bait consisting of dead fish or "klip-fish". He further tried to determine their numbers partly by the aid of divers, partly by means of a big bottom-sampler of special construction. But also the problems of the size-limit of the eel engaged his mind and required many investigations; about these he wrote an article in "Dansk Fiskeritidende", which also brought an article on damage to fish in wheels caused by seals and cormorants.

Report No. 18 for 1909 contains 3 papers, all written by Dr. Petersen: "The yield of the Limfjord fisheries in recent years and the transplantation of plaice in 1908", "Biological investigations on the stock of plaice in the Limfjord" and "The yield of the Prawn fishery from 1885—1907 and its improvement by means of protection". In the first of these papers the yield of the great transplantation in 1908 is estimated at 100—150,000 Kr. by an expenditure of 15,000 Kr. In the second paper it is shown that the size and the number of the plaice change from the Thyborøn Kanal to the central part of the Limfjord and that the recruiting of the plaice population of the whole fjord takes place from the west. In the last paper Dr. Petersen shows that there has been a rapid decrease of the prawn fishery and urgently agitates for a protection of about 4 weeks in summer. Unfortunately, this protection was not put in force, and the result was a further decrease of the prawn fishery.

Many scientists visited the "Sallingsund" in the summer of 1908. Among others the journal mentions Prof. Rørdam, Dr. J. Hjort, Dr. Th. Mortensen, Dr. Müller, the forester in-chief, Prof. W. Johannsen and cand. (later Professor) P. Boysen Jensen. In May the steamer made a demonstration trip with the pupils of the school for fishermen at Kerteminde.

In 1909 Dr. Petersen withdrew from Kommissionen for Havundersøgelser and thus abandoned the collaboration with "The International Council for the exploration of the sea". To a great extent his reasons for this step were undoubtedly personal ones, but he still kept up the contact with several leading members of the council, above all with his old friend Dr. Johan Hjort, who, as will be seen later on, paid frequent visits onboard the "Sallingsund" and highly valued Dr. Petersen.

THE EXTENSION OF THE BOTTOM INVESTIGATIONS

The following year added further to the investigations on the amount of fish food on the bottom of the sea. Although the Limfjord was still preferred as an object of examination, some samples were now also taken in the Sound, the Baltic and the southern Kattegat. Besides this studies were initiated concerning the food of the bottom animals, and mag. Boysen Jensen collected material for an investi-

Fig. 26. Johs. Johansen (Høj).

gation on the amount of nourishment contained in the upper layer of the bottom and in the plankton. But as usual Dr. Petersen at the same time made many other experiments. In throwing out 800 marked plaice in the Nissum Bredning in the Limfjord during the fishing of plaice for transplantations he tried to estimate the quantity of plaice in this water from the number of marked fish (22) caught by the fishermen on the following day. He also tried another method by constructing a "fish-fork" with a long cross bar with iron spikes, by means of which gear it was supposed possible to transfix the plaice in the same way as the eel with the eel-spear, so that their numbers could be estimated. But in spite of many experiments not one plaice was caught in this way, and no publications ever appeared concerning these methods of "counting" the plaice.

Dr. Petersen was also interested in the ex-

ploitation of the sticklebacks S. of Sealand. He constructed a fish-pond for the hatching of prawns at Nykøbing M. and an aquarium for the keeping of plaice in the harbour of Thisted. But he was specially interested in the above-mentioned question concerning the exploitation (and extermination) of the whelks in the Thisted Bredning, and in Report 19

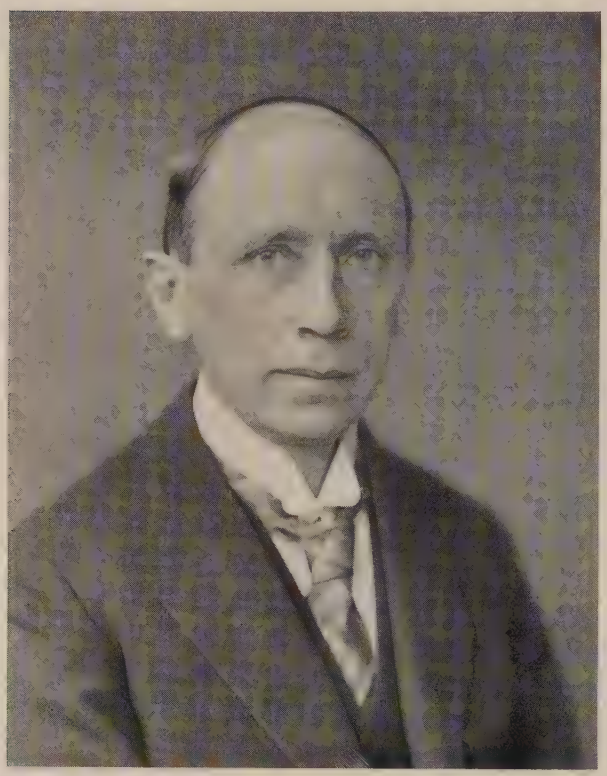

Fig. 27. P. Boysen Jensen.

for 1911 he gives an account of the condition of matters. In this report Dr. Petersen says that in the summer of 1910 the number of predatory whelks (*Buccinum undatum*) in the Thisted Bredning might be estimated at about 85 million specimens or more than 16,000 barrels. By an energetic fishing for these harmful animals with 240 "hive-traps" throughout the summer a total of 2.5 million specimens or 480 barrels were caught, *i. e.* only $^1/_{34}$ of the calculated stock. Besides this the experiments of using the whelks for bait or poultry fodder on a large scale failed, and Dr. Petersen therefore considered it likely that the matter would not pay. Moreover, the whelks seemed to be less numerous in 1910 than in 1909; this was considered a consequence of the fact that an unusually large quantity of cod had entered the Limfjord in 1908; they had now grown so big, that they could begin to eat the whelks. It may be added that the nuisance of the whelks in fact decreased during the following years.

On March 1st, 1910 K. Trondhjem was appointed cook of the "Sallingsund". He is still steward of the Station, and during his long time of service he has served a great number of tasty dishes—most of them of course made of fish—to the various scientists at the Station. In April 1910 Joh. Johansen (Høj), now 70 years old, retired after 20 years of faithful service at the Station. At the same time his son Niels became mate of the "Sallingsund". In "Dansk Fiskeritidende" for April 19th, 1910, Dr. Petersen celebrated the memory of "old Johansen" in a handsome article. He died at his native town Kerteminde on January 1st, 1925.

Of visitors onboard the journal mentions Prof. H. Jungersen, Dr. Th. Mortensen, Dr. Knut Dahl, cand. Boysen Jensen, cand. Chr. D. Lunn, F. V. Mortensen, Inspector of Fisheries, and the Minister of Agriculture. Most of the time cand. Sell was substitutional assistant while the present author, after having passed his degree examination in the summer of 1910, served his time onboard H. M. S. "Ingolf" on a cruise to the West Indies.

In 1911 cand. Sell acted as an assistant in the month of April, but was then succeeded by the present author who from now on was regularly employed under Dr. Petersen to his demission in 1926. The work of the summer mainly comprised investigations with the bottom-sampler, which were now extended to the deeper parts of the Kattegat. In June a visit was paid to Prof. O. Pettersson in Gullmarsfjorden and the biological station at Kristineberg; during this visit a lot of samples were taken in Gullmarsfjorden. In the North Sea a number of samples were taken from the life-steamer "Vestkysten" out to depths of 280 m.

Among the visitors of the "Sallingsund" in the summer of 1911 may be mentioned F. V. Mortensen, the Inspector of Fisheries, cand. Chr. D. Lunn, Dr. Wesenberg-Lund, Prof. O. Pettersson, Dr. Østergren, Dr. Jägerskjöld, Dr. J. Hjort, Dr. Boysen Jensen and Prof. Hensen of Kiel.

THE VALUATION OF THE SEA

In 1911 appeared "The Valuation of the Sea I" with the sub-title "Animal Life of the Sea-Bottom,

its food and quantity" as Report 20 from the Station drawn by Dr. Petersen and Dr. Boysen Jensen. It was the first of a series of papers published by the Station on the animal life of the sea-bottom. It made a great sensation, first and foremost on account of the new apparatuses and methods used here for the first time and securing exact information on the species and quantities of the bottom animals everywhere in the sea, but also because the authors of this paper tried to show that the principal food of the bottom animals is not the plankton organisms (the common belief of previous times), but the dust-like detritus, which forms the upmost layer of the sea-floor or is suspended in the water immediately above the bottom. Besides of varying quantities of inorganic material this detritus consists of decaying components of plants and animals. Besides this Dr. Petersen in this treatise brings an abundance of interesting information and reflections, particularly on the food requirements of the fishes.

THE ANIMAL COMMUNITIES OF THE SEA-BOTTOM

The results of the bottom samplings published in Report 20 mostly dealt with the Limfjord, but Report 21 with the title "Valuation of the Sea II. The animal communities of the sea-bottom and their importance for marine zoogeography" and written by Dr. Petersen brings the results of the greatly extended bottom investigations of 1912. It appeared in 1913, and, like the previous one, made great sensation. On the basis of many thousands of bottom samples taken in Danish waters Dr. Petersen was now able to divide the bottom animals into different animal communities, characterized by one or several of the most frequent animals of the area in question, the "characteristic animals" (Fig. 38). He was further able to bring a map showing the distribution of the animal communities in the Kattegat, the Belt Seas and the Baltic. I shall not enter into the details of this fundamental work, but shall rest content with a reference to the fact that it caused a great number of similar works to be carried out both here and abroad. In former times the principal gears of the zoologists had been the trawl and the dredge. Now Dr. Petersen showed that these gears, which fail to catch a great number of animal forms, do not yield an exact image of the occurrence and frequency of the bottom animals: for this purpose it is necessary to avail oneself of the quantitative work of the bottom sampler. As a matter of fact the bottom sampler before long was acknowledged everywhere and soon came to be considered a necessary gear of every research vessel.

By the aid of Civ. Eng. A. Møller Dr. Petersen had in 1912 improved the construction of the bottom sampler by using a pelican-hook as a release. Further-

Fig. 28. The improved type of bottom sampler, 1912, with sifting apparatus below.

In the background Saabye, Ch. Eng., L. P. Larsen, Sailor (later mate), and N. Johansen, Mate (later captain).

more, a bigger and heavier bottom sampler had been constructed for use in hard bottom (Fig. 28). This gear is more rapid and reliable than the old one, and a great number of samples were taken with it in all Danish waters in the summer of 1912. From the "Michael Sars" Dr. Hjort took bottom samples for Dr. Petersen in the North Sea.—Besides this methods were tried for the determination of the production of eel-grass and of small gastropods and other animals in the littoral zone.

Visitors onboard in 1912 were Prof. Th. Classen of Moscow, Dr. Boysen Jensen, Docent Stamm, Dr. Th. Madsen (from the Serum Laboratory), Dr. J. Hjort, Mag. H. Ditlevsen, Prof. Raunkjær, and Prof. Reibisch, Dr. Müller and A. Wulff from the "Poseidon", the German research vessel.

In the same year Dr. Petersen was made Doctor

Fig. 29. C. G. Joh. Petersen as L. L. D. of the University of St. Andrews.

honoris causa (L. L. D.) at the University of St. Andrews in Scotland, an honour which he esteemed highly.

In 1913 the investigations with the bottom sampler were continued, and the present author studied the stomach contents of both fish and lower animals. Various gears were constructed and tried, *i. a.* a catching apparatus to be hauled along the sea-floor fixed on a sledge and intended to be hauled a certain distance from the anchored ship. This gear was used in order to determine the numbers of rapid animals that could not be taken with the bottom sampler, for instance mysids and other crustaceans. In many localities it turned out that large quantities of mysids were standing immediately above the bottom; in the Great Belt for instance more than 100 *Mysis mixta* were found per 1 sq. m. New types of bottom samplers were also constructed, *i. a.* a big and heavy one with teeth, intended to dig out *Mya* and *Arenicola* of hard bottom; this gear, however, never came to be much used.

Among foreign scientists visiting the Station in 1913 may be mentioned Capt. Seymour Sewell, Calcutta and Dr. Gast, Naples.

THE NOURISHMENT OF THE BOTTOM ANIMALS

Report 22 of the Biological Station was printed in 1914 and contains 4 papers, one by Dr. Boysen Jensen: "Studies concerning the organic matter of the Sea Bottom", one by the present author: "Food and Conditions of Nourishment among the communities of invertebrate animals found on or in the sea bottom in Danish waters" and two smaller papers by Dr. Petersen: "The Work of the Biological Station from 1889—1914" and "Appendix to Report XXI from the Danish Biological Station". In the first of these papers the author on the basis of chemical analyses of the quantities of carbon and plankton examines whether the organic matter of the sea bottom may be supposed to originate from the vegetation of eel-grass or from the plankton. He arrives at the conclusion that in the closed waters, the fjords, the organic matter originating from the eel-grass makes up the greater part and in the opener waters at least half the amount present; in the deeper regions of the Kattegat, however, the plankton organisms probably play a prominent part although this has by no means been proved. He arrives at the same result in calculating the annual production of eel-grass and of plankton. He further shows that the organic matter of the sea-bottom contains more nitrogen than the fresh eel-grass, but that the decaying stages of the latter shows comparatively more nitrogen, and finally that water samples from the Limfjord contain far more detritus than plankton.

In the second paper the present author basing on examinations of the contents of stomachs and intestines of a great many bottom animals has tried to show that the living vegetable plankton plays a most inferior part in the nutrition of the bottom animals as compared to the benthic plants (eel-grass, algae) and the upmost detritus layer of the sea-floor; the latter contains minute particles of plants and animals originating both from the plant zones of the coast and from the plankton. The majority of the bottom animals are detritus and plant eaters.

Besides this an attempt is made to classify the different bottom animals according to their way of taking their food, and to calculate the quantities of "producers" and "consumers" of the different animal communities.

Dr. Petersen's survey of the work of the Station during the first 25 years is quite brief and particularly emphasizes the results achieved by the work of the Station during these years. Among other things he mentions that the transplantations of plaice and a working place in winter. As will appear from the following the Station already in the next year got the disposal of aquaria, which, however, were put up in small sheds at Nyborg, not in "fixed premises".

The small "Appendix to Report 21" consists of a map with quite a brief text showing the distribution of the animal communities of the sea-bottom outside Denmark, as Dr. Petersen thought it likely to be from his studies of the fauna lists in the literature. By the nature of the case this could of course only

Fig. 30. The moorage of the Biological Station at Avernakke in the Nyborg Fjord. The "Sallingsund" is fastened to the anchored transport. May 1915. H. Blegvad phot.

the re-arrangement of the exploitation of the oyster fishery alone yield so great annual amounts, that it means a direct rentability of the Station.

It is characteristic of Dr. Petersen that among the tasks of the future beside protection, transplantation, combating of harmful animals and the utilization of the bivalves as a food matter he mentions a cultivation of the bottom of the sea for the purpose of procuring more food for the utility animals, a problem which must still be said to await its solution. As a wish on occasion of the semi-jubilee Dr. Petersen states his desire for "fixed premises on land with aquaria", a wish that has been complied with only in part. Even then the Biological Station only had the old transport in the harbour of Nyborg as a fixed point during the summer half-year and a small three-roomed flat in Willemoesgade (Copenhagen) for be a hypothetic map, but it must be said that in many points it has turned out to be correct to an amazing degree.

THE GREAT WAR 1914—18 INVESTIGATIONS ON THE COASTAL FAUNA. AQUARIA, BIVALVES AND GOBIES

In 1914 the investigations with the bottom sampler were continued and extended to Swedish and Norwegian waters. During a visit at the Swedish zoological station at Kristineberg in June the Koljefjord was "valued". At the station was still preserved the "Bottenhuggare" (bottom-cutter) that was used in former times by Torell and Nordenskjöld and which in its way was a small, primitive bottom sampler. In July a trip was made to the Oslofjord, and the

surrounding waters were valued. But then the war came, abruptly putting an end to these investigations. On 1. August the semi-jubilee of the Station was celebrated: in the harbour of Nyborg the steamer was laying decked with flags, the crew had a day off and congratulations arrived from far and near. But the feeling of impending danger to our small country with the war coming on spoilt the festivity. The author himself went to Copenhagen in the evening to report himself, but as there was no use for him yet, he at once returned to Nyborg. On 3. August

Dr. E. Hentschel of Hamburg and Prof. Mewes of Kiel; from the visit in Sweden Prof. H. Théel, Prof. Jägerskjöld, Prof. Appelöf, Dr. Östergren, Docent H. Pettersson and Dr. K. A. Andersson and from the visit in Oslo Dr. J. Hjort and Prof. Gran. It was in 1914 that the transport got a fixed anchorage in the Nyborg Fjord (it had formerly been moored in the harbour) inside Avernakke where a bridge was built from land to the anchorage (Figs. 30 and 31). On a small piece of land hired ashore a couple of sheds were built for about 20 aquaria—

Fig. 31. View from the deck of the transport towards land.
The long bridge connects the transport with the shore. 1915. H. Blegvad phot.

the "Sallingsund" was laid up at Skelskør and the crew dismissed to their homes. But already one month later the steamer returned and was used for a few investigations at Nyborg and Svendborg. The rest of the time was employed for investigations of lakes and fjords from hired boats: for instance the Sorø Sø (Lake) and the Ringkøbing Fjord were examined with the bottom sampler. In April 1914 Chr. Christiansen retired as captain of the "Sallingsund" and was succeeded by Niels Johansen. From August of the same year L. P. Larsen was promoted to be mate; he had succeeded "old Johansen" as sailor in 1910. In 1932 Larsen had to retire as mate on account of an increasing deafness, but he is still working at the Station as a laboratory assistant.

Of foreign scientists onboard the journal mentions

both large ones of concrete and smaller ones of glass. Many interesting observations were made in these primitive tanks, not only concerning the bearing of the surroundings on the bottom animals but also concerning their growth and conditions of propagation: it was in such a tank that I found eggs deposited by *Arenicola marina*; I had searched for them for years in nature, but had only been able to find the tiny larvae which were also unknown down to that time (see Medd. fra Naturhistorisk Forening, 1923). These tanks also made it possible for me later on to study the biology of the gammarids.

In 1914 Dr. Petersen became a member of Videnskabernes Selskab (The Royal Danish Scientific Society), an honour which he valued highly. He frequently attended the meetings of the society, and

sometimes he himself read small papers to the assembly.

Also in 1915 the investigations were greatly hampered by the war though it was possible to sail the waters round Funen, the Limfjord, Isefjorden and the fjords of East Jutland. While I was called out in the months of April—July Dr. Gast acted as an assistant onboard. The investigations mostly dealt with the littoral region and a new gear, the "young fish seine", was used for the purpose of acquiring information on the amount of animals in this region. Also the goby species were studied, and experiments were made with poles put out for the mussels. As visitors of the Station are mentioned Dr. Boysen Jensen, Mag. Bardenfleth and cand. P. Kramp. On Nov. 1st, Ahlmann Andersen became sailor onboard the steamer.

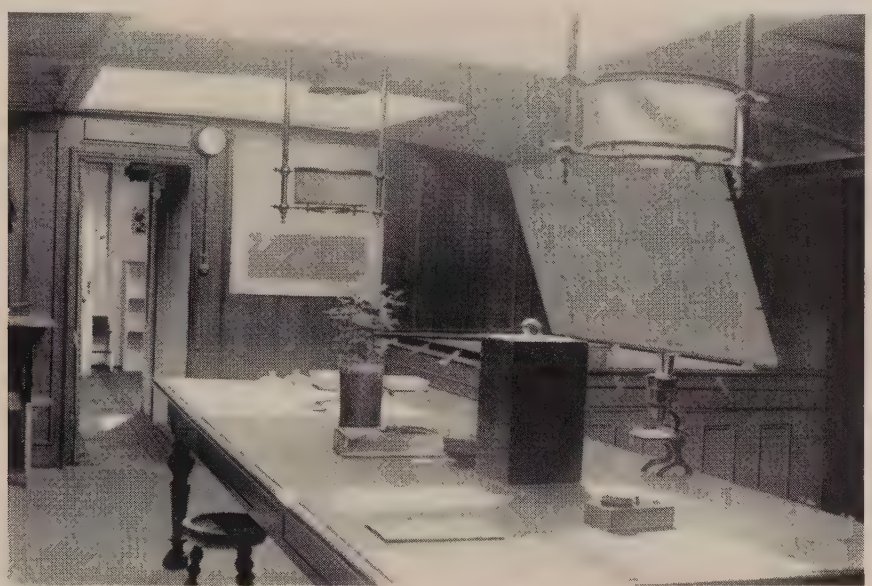

Fig. 32. The working room in the transport. In the background to the right the cover of the well. May 1915. H. Blegvad phot.

Report 23 of the Biological Station (1915) contains two papers by Dr. Petersen: "On the Animal Communities of the Sea Bottom in the Skagerak, the Christiania Fjord and the Danish waters" and "A Preliminary Result of the Investigations on the Valuation of the Sea". The former was based on the work of the summer of 1914 when we reached a depth of 670 m in the Skagerak and managed to find the same animal communities in the deep Swedish and Norwegian fjords as in the Danish waters. To this account of the composition and the characteristic animals of the different animal communities Dr. Petersen attaches many interesting remarks on the fish fauna of the different waters, depths and communities of bottom animals. In the latter paper Dr. Petersen on the basis of the valuations, the quantitative investigations on the annual production of the eel-grass and the fishery statistics puts up a scheme of the metabolism in the Kattegat. In this water he estimates the amount of "useful" animals, *i. e.* small bivalves, worms and other fish food at about 1 mill. tons and that of the "useless" animals, *i. e.* bottom animals not eaten by the fish, at about 5 mill. tons. It is further shown that in the household of the sea it is more expensive to produce cod, which live on large crustaceans, gastropods and small fish (which in their turn live on the useful small animals), than to produce flatfish, which feed directly on these small animals (Fig. 37). Dr. Petersen reckons that for the production of the 6,000 tons of cod that were caught every year in the Kattegat 100 times as much, or about 600,000 tons, of the useful small animals are necessary, but for 5,000 tons of plaice are required only 50,000 tons of useful small animals. Also the "useless" and "detrimental" animals like starfishes, predatory gastropods, etc. take their part of the useful small animals, and so there seems to be no

superabundance of the latter. He ends by asserting that the sea could yield much more if we were able to utilize the bottom animals, for instance mussels and oysters, or even the vegetation to a higher degree instead of making the détour through the predatory animals, the fishes.

The investigations of the summer of 1916 were mainly pursued in the Nyborg Fjord, Svendborg Sund and the Limfjord. Dr. Petersen was still busily engaged in the problem of the mussels, and some hens (and a small dog!) were kept at the Station for the purpose of trying the value of the mussels as a feeding matter. Furthermore, many mussel poles were put out both at Nyborg and in the Limfjord. At the same time Dr. Petersen was still revolving the idea of the "improvements of bottom" mentioned above. He constructed a rake with which to remove obstructive vegetations of the eel-grass, and in the journal for Oct. 10th, 1916 we find the entry "suggestion for an eel-grass trawl". But this gear was never constructed, neither did the experiments show any practical results. He little thought that 15 years later the eel-grass would disappear from our waters as the result of a disease, thus causing very great changes in the animal life of the littoral zone.—Besides this the littoral zone was subjected to an intense study, both in a quantitative and a qualitative respect. Dr. Petersen himself principally studied the youngs of the gobies, while the present author examined the food of the fishes and the breeding and growth conditions of the small crustaceans both in nature and in the tanks at Nyborg.—Of visitors onboard the journal only mentions cand. Chr. D. Lunn.

The report of the Station for 1916, No. 24, contains two papers. The former, by Dr. Petersen, "On the Development of our Common Gobies (*Gobius*) from the Egg to the Adult Stages etc." brings the results of the studies mentioned above; the youngs of the three most familiar species are described here. The latter, by the present author, "On the Food of fishes in the Danish waters within the Skaw" contains the results of the many stomach analyses carried out onboard by me in the course of the years. In this paper I have tried to define the importance of the different food matters after weighings of the stomach contents and the fish themselves. Furthermore, investigations had been made as to the time of the day at which the different species of fish take their food. The classification of the whole material is based on the animal communities.

Fig. 33. The "Sallingsund" and the transport viewed from the bridge. May 1915. H. Blegvad phot.

Also in 1917 and 1918 most of the investigations, on account of the war, had to be confined to the waters round Nyborg—Svendborg and the Limfjord. Mussel poles were put out in various localities, and the studies of the youngs of the gobies were continued. In the winter of 1917—18 the "Sallingsund" was extensively repaired at Orlogsværftet (the naval shipbuilding yard). At the wish of Dr. Petersen the name of the steamer was now altered into "Japetus Steenstrup" in memory of his old teacher, to whom, indeed, he showed so much likeness. As

Fig. 34. The tool-shed (to the left) and the tank house (in the center) of the Biological Station. In front of the tool-shed a pair of whale jaws. 1922. K. Schäferna phot.

visitors onboard the journal mentions Dr. Boysen Jensen, Dr. Th. Mortensen and Prof. Th. Classen.

Report No. 25 was printed in 1918. It was called "The Sea Bottom and its Production of Fish-Food" and is a summary of the results achieved by Dr. Petersen with the bottom sampler and the other quantitative gears that had been used from the Biological Station in later years. Of new things the paper mentions the experiments made in order to determine the quantities of animals of the littoral zone where the bottom sampler cannot be used. Besides this the paper contains an interesting account of the regional distribution of the different species of fish in our waters and—in the last chapter —some reflections on what can be done for the purpose of increasing the yield of the fishery, not only of fish but also of mussels, oysters and other animals.

Report 26, 1919, contains two papers. The former, by Dr. Boysen Jensen, "Valuation of the Limfjord. I. Studies on the Fish-Food in the Limfjord 1909—1917", deals with the problem of the production of fish food in the Limfjord, illustrated by a study of the growth and consumption of the small bivalves and worms that constitute the principal food of the plaice. He arrives at the conclusion that the production of these animals is subject to great annual variations: in the Thisted Bredning he has calculated the values to range between 42 and 77 g of rough weight per 1 sq. m. The connexion between the amount of food and the plaice fishery is discussed; the author thinks that too many plaice may easily be implanted, which in his opinion was the case in certain years.

In the latter paper "Our Gobies (*Gobiidæ*). From the Egg to the Adult Stages" Dr. Petersen once more deals with our goby species. No less than 8 species are now described and pictured. Several of these species are so closely related, that thousands of individuals had to be examined before the correct characters for the distinction of the species could be established. A great and useful work was done here.

AFTER WAR TIMES
CHANGES IN THE STOCK OF PLAICE IN THE BELT SEA

The field of action of the "Japetus Steenstrup" of course increased somewhat after the end of the war, but the investigations were still hampered by the after effects of the war both in 1919 and 1920; among other things peat often had to be used for fuel. Therefore the investigations of these years were mostly confined to coastal waters such as the Limfjord, the Isefjord, the Sound and the waters round Funen. Valuations and fishings were carried out, and the studies on the application of the mussels were continued. Of visitors onboard the journal mentions Mag. (later Professor) R. Spärck, who from now on was attached to the Station as Dr. Petersen's assistant in the oyster investigations, Prof. Classen, Dr. Boysen Jensen and Dr. (later Professor) R. Ege. In 1920 the attention of Dr. Petersen was specially called to the changes in the plaice population of the Belt Sea: he noticed that the plaice from a dense stock of lean, old, "hairy" and nearly inedible fish at the end of the century had now changed into big, smooth fish which, however, were much fewer in number. This impression was confirmed during numerous conversations with the fishermen.

In Report 27, 1920, Dr. Petersen enters upon this problem. In the paper "On the stock of plaice in relation to the intensive fishing of the present times in the Beltsea and other waters" he shows that the thinning of the stock on account of the increased fishing intensity has caused the disappearance of the very old plaice, but at the same time the growth of the remaining individuals has increased, so that the annual yield of the fishery has risen very much both in weight and value.

It is hardly outside the mark to say that this work was fundamental in the future interpretation of the problem of "overfishing" all over the world.

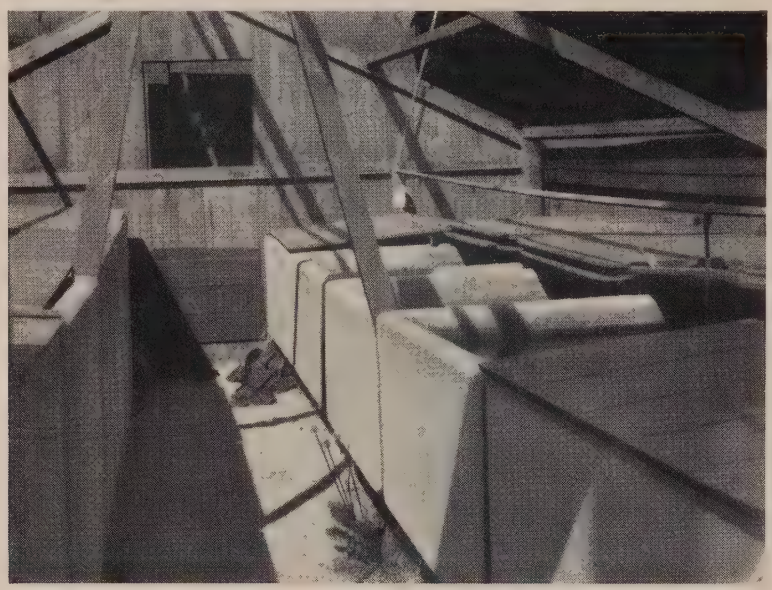

Fig. 35. The concrete tanks of the Biological Station. 1922. K. Schäferna phot.

Previously this problem had been considered only from the point of view that if the fishing was too intense, there must gradually be too few plaice left. Now we had to admit that there was also a possibility of fishing too little. As a matter of fact the plaice population of the Belt Seas was too dense about the end of the century; the fish were small and lean, the overpopulation causing that the plaice could not get food enough—they were partly starving. When this dense stock was thinned, the plaice got sufficient food, and their rapid growth counterbalanced the loss suffered by the stock from the intense fishing.

It was the bottom sampler that gave information of the plaice food present on the bottom of the sea and showed that in most localities it did not superabound; without the knowledge aquired in this way

Dr. Petersen would hardly have got a correct idea of the state of things. He shows that a heavy yield of the fishing is conditioned by a spreading of the plaice population over a vast area, so that all the nourishment present can be turned to use. In this connexion he points out that in the Belt Seas and similar lesser waters the spreading of the youngs, which grow up near the coasts, to the growing places with their rich nourishment takes place much more easily than in open waters like the Kattegat and the North Sea because the distances are much smaller in the former than in the latter waters. Of course Dr. Petersen was quite clear of the fact that the thinning of the stock could be urged too ardently; he therefore makes an earnest appeal for a protection of the plaice during the spawning time because the plaice at this time are lean and the females full of roe and of small market value.

In the summer of 1921 there were continued investigations on the changes in the plaice population, especially by fishing experiments in the Belt Sea and the Baltic. The Limfjord, however, a water in which Dr. Petersen always had a particular interest, was not forgotten: fishing and valuation were carried out here both in spring, summer and autumn. By comparative fishing experiments it was calculated that no less than about 114 millions of plaice were standing in the Nissum Bredning in spring, which means that every plaice has only 1.3 m² of bottom at its disposal! It is easily understood that the plaice are starving here and that the food animals never attain a proper size before they are eaten.

Among the visitors in the summer of 1921 may be mentioned Dir. V. Lunn who had taken over the oyster leasehold after the premature death of his brother, cand. Chr. D. Lunn; further Mag. M. Porsild from Disko in Greenland, Dr. K. Schäferna of Prague, Dr. Reibisch and Prof. J. Hjort. At the end of June I myself went to Lowestoft in England in order to demonstrate the use of the bottom sampler onboard the English research vessel "George Bligh"; I was onboard this steamer in July when she went to Copenhagen with several scientists for the meeting of the International Council. That Dr. Petersen—without directly attending the meeting—maintained the contact with the collegues in the international exploration of the sea is seen by the fact that Mr. Maurice, the president of the Council, made a one-day trip in the Sound with the "Japetus Steenstrup" together with their Highnesses Prince Valdemar and Prince Georg and Prof. Hjort. The next day the steamer was visited by 8 English and Scottish attendants on the meeting and two days

Fig. 36. The "Sallingsund" in 1915. A pair of otter boards is hanging from the trawl gallows. In front of the funnel the caboose, abaft the laboratory. Chart-house and wheel were placed behind the funnel. Two schooner sails could be hoisted to steady the boat in bad weather. H. Blegvad phot.

later by 7 other fishery biologists from Norway, Holland, Scotland and Ireland. Before the "George Bligh" returned to England it payed a visit at Nyborg where the scientists inspected the transport and the tanks. In August Dr. (later Professor) R. Ege and Mr. Bjerkan, a fishery adviser from Norway, visited the Station.

Report No. 28 of the Station appeared in 1921 and contains a treatise by the present author termed "On the Biology of some Danish Gammarids and Mysids". It was accepted for the defence of the philosophical doctorate at the University of Copenhagen in March of the same year. The reason why I pursued this subject was the fact that previous investigations had shown that the fishes of the littoral zone principally lived on these crustaceans though the momentary stock was rather small. They must therefore be supposed to be very prolific, and on the basis of tank experiments I was able to show that this was really the case. Every female gammarid (*Gammarus locusta*) hatches up to 7 broods of youngs, and 4 generations of fry appear in the course of summer, so that one pair of gammarids during one summer will be able to produce an offspring of more than 200,000 individuals. Our 3 commonest *Mysis* species were examined in the same way; like the gammarids they become no more than one year old, but they hatch 3 broods of eggs, and 2 or 3 generations appear every summer. One pair of mysids is able to produce between 600 and 1300 individuals according to the species.

The investigations on the changes in the plaice population were continued in the summer of 1922. In the autumn experiments were made to watch the migration of the silvery eel at night in the open sea by means of a search-light. Among the visitors onboard during this summer may be mentioned Teilmann-Friis, the dispensing chemist, Dr. A. Hagmeier, Helgoland, Dr. Schäferna, Prague, Dir. V. Lunn, Mag.s R. Spärck and I. Lieberkind, Prof. Raunkjær and Lektor (ɔ: lecturer) Bøving-Petersen. At the beginning of August the "Japetus Steenstrup" paid a visit at Kiel on occasion of the congress of limnologists. Prof. V. Hensen and Prof. K. Brandt dined onboard, and 30 attendants of the congress under the leadership of Prof. Thienemann joined in a trip on the Kieler Fjord, during which the working of the bottom sampler was demonstrated.

In September Dr. Petersen went to England in order to be appointed Doctor *honoris causa* (D. sc.) at the University of Leeds. In October and November of the same year I made a study tour to the Biological Stations of Germany and France where I—thanks to the name of Dr. Petersen—was heartily welcomed everywhere.

Report 29, 1922, contains two small papers by Dr. Petersen, "On the Stock of Plaice and the Plaice Fisheries in different Waters" and (as Appendix I) "The annual transplantation of plaice in the Limfjord". The former is a continuation of his work in 1920. He produces further material showing the changes in the plaice population and earnestly pleads for a raising of the minimum size-limit in the Belt Seas and for an extermination of the animals noxious to the plaice fishery, among which he reckons the common dab, and no doubt rightly. A very important question is discussed in detail by Dr. Petersen: Will the spreading of the young plaice from the coasts to deeper water—which, as mentioned, is so important to the stock as a whole—be more rapid if the population standing at the coasts is dense or if it is more scattery? In other words: should a dense stock of young plaice at the coast be thinned in the hope that the remaining plaice will grow more rapidly and migrate into deeper water with better conditions of nutrition at an earlier point of time? This problem, which is so very important in the North Sea where trawlers through many years have made enormous catches among the small plaice near the coast, cannot yet be said to have been solved though probably most fishery biologists nowadays are of opinion that the young fish should be protected. In his paper Dr. Petersen himself does not decide for one view or the other, but he emphasizes that after we have seen that some degree of a thinning may be useful, we cannot then and there assume that the more small plaice are found on the grounds the more of them will emigrate at an earlier point of time.

The second small paper in Report 29 after a short mention of the antecedent history of the transplantations brings a statistic of the numbers of the transplanted plaice and the yield of the fishery in the Thisted and Visby Bredninger. On the basis of this comparison Dr. Petersen considers it allowable to conclude that no more than 40 plaice should be transplanted per 1 hectare. In comparing the results of the fishing experiments of the Biological Station in the Thisted and Nissum Bredninger he

arrives at the result that at least 55 mill. plaice are found in the latter water.

Dr. Petersen's works on the animal communities of the sea bottom had excited attention also outside the circle of scientists. The teachers were much interested in acquiring collections for the schools, so that they could illustrate the Danish communities by their characteristic animals. On the suggestion of Lektor Stockmarr a great many bottom animals were therefore collected in 1923 for the use of teaching in the higher schools. Ahlmann Andersen, one of the sailors of the Station, with great dexterity and skill prepared them and fixed them on 8 tablets showing the principal animal communities of Danish waters. Many schools all over the country have acquired these beautiful tablets in the course of the years.

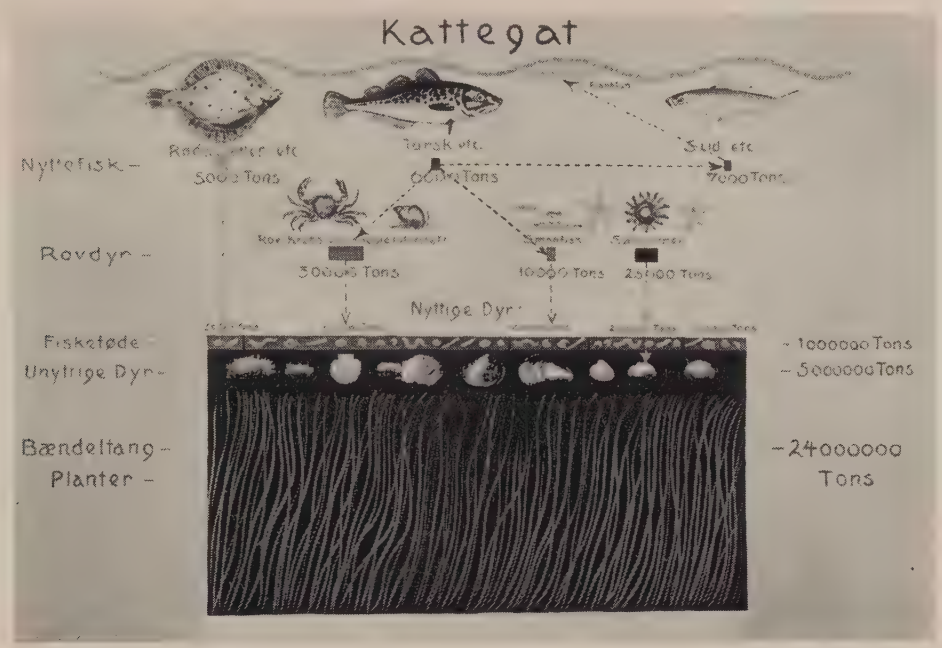

Fig. 37. The metabolism of the sea, illustrating Dr. Petersen's paper in Report 23.

In the summer of 1923 and 1924 the work otherwise dealt with investigations on the stocks of fish in our inner waters, especially the Baltic, in which the fishing for plaice now started for good. The experiments of watching the eel in the surface at night by artificial light were continued, and we succeeded in observing—and catching—several of them S. of Funen, at Nyborg and in Storstrømmen.—Visitors onboard were Mag. Spärck, Dr. Th. Mortensen, Prof. C. O. Jensen, Prof. A. Krogh, Lektor Gemzøe, F. V. Mortensen, the Superintendent of Fisheries, Dr. R. Ege, Mr. O. Sund, Fishery Adviser of Norway, Mr. Borley from England, Mr. E. Watkin from Wales and 15 members of the British Museum's Association. In the winter Mr. Stephen from Scotland, who had been making bottom samplings in the northern part of the North Sea, was in Copenhagen where he discussed the animal communities of this water with Dr. Petersen and the present author.

In 1924 appeared Report No. 30 of the Station: "Studies on the Biology of the Oyster (*Ostrea edulis*) in the Limfjord, with special Reference to the Influence of Temperature on the Sex Change". This was the result of Mag. R. Spärck's studies on the oyster of the Limfjord during the years after 1919 when Dr. Petersen attached him to the Station as an assistant in the question of the oyster fisheries. The paper passed as a thesis for the doctorate. The author shows that the Danish oyster is a protandric alternating hermaphrodite and that the temperature exercises a considerable influence on the breeding conditions of the oyster, the development of the eggs

being forwarded by high temperatures and practically stopping at 10—12° C. Further that both temperature and salinity determine the limits of the distribution of the Danish oyster. As to the food of the oyster he shows that the oyster may be fed with plant detritus that is free from organisms and that this plant detritus plays a prominent part in its nutrition.

Fig. 38. The "Venus community". One of the illustrations of the animal communities in Report 25. Reduced.

THE PLAICE POPULATION OF THE BALTIC

As mentioned above a large plaice fishery had started in the Baltic in the years immediately before. Fishing boats from various harbours of this country took large quantities of plaice at Darss, Rügen and Bornholm. And exactly the same changes as had formerly been observed in the plaice populations of the Belt Seas now took place in the Baltic: the plaice that had been small, lean, old and hardly worth eating were gradually fished out and succeeded by big, smooth and high-fed fish, which made an excellent article of trade. But the heavy catches of plaice that were common at the beginning of the twenties could no more be taken: the plaice population was decreasing in number.

This development of things had been watched with attention by the Biological Station, and during the years 1921—24 many fishing experiments had been carried out in the western part of the Baltic. The results of these investigations were given by Dr. Petersen in Report 31, 1925: "The Influence of Fishing upon the Stock of Plaice in the Baltic during recent Years". By means of age analyses he shows that the plaice population is now younger than before, but also of quicker growth and fewer in number; he still agitates in favour of a protection in the Belt Sea and parts of the Baltic.

Report 31 further contains 2 short papers by Dr. Petersen: "Investigations on the Size of the Stock of Oysters in the Limfjord 1924" and "Report to the Ministry of Agriculture concerning increased

Motor-Fishing in the Limfjord", both of them testifying to the unabated interest of the author in the Limfjord. In the former paper an account is given of the decrease of the oyster population since 1907. On the basis of countings by diver the stock is calculated to have been reduced from about 90 millions in 1907 to 7.5 millions in 1924. During the severe winter of 1923—24 nearly half the adult oysters had died. In the latter paper the author calls attention to the danger connected with an increased motorization of the fishing boats in the Limfjord.

of the seasonal variations in the quantities of fish food from year to year in the different waters, based on the information obtained by the use of the bottom sampler. The last paper of Report 31: "A Comparison between the Danish Oyster-Beds and those in Holland and the South-West of France" is by Dr. Spärck; the author describes the natural conditions on the oyster-banks at the coasts of France and Holland and arrives at the conclusion that the Limfjord is the only Danish water in which conditions are fairly like those mentioned above.

Fig. 39. The "Japetus Steenstrup" entering the harbour of Aalborg. May 1923.

He emphasizes the fact that the boundaries of this water are so narrow, that the greatest net yield is got by small-scale fishing, and by means of the fishery statistics he shows that the yield of the fisheries has not been rising for many years in spite of the ever increasing intensity of the fishing.—Dr. Petersen's words are still valid, but time has shown that it is impossible to dam up the development that tends to an ever increasing motorization of the fishery.

Report 31 further contains a paper by the present author: "Continued Studies on the Quantity of Fish Food in the Sea Bottom". The food animals of the sea bottom are divided into 2 classes according to their fitness for fish food, and the ratio between edible and inedible animals of the different animal communities is discussed. Finally there is a survey

Among the visitors of 1925 may be mentioned Dr. Th. Mortensen, Mag. H. Ditlevsen, Mag. K. L. Henriksen, Dr. R. Spärck and Mr. F. M. Davis from the marine laboratory of Lowestoft.

Also a great part of the summer of 1926 was devoted to investigations on the flat-fish population of the Baltic. But the Limfjord was not forgotten: the usual investigations were carried out both in spring and autumn, this time with a special view to the ratio between the quantities of cod and viviparous blenny. Finally, some investigations were made on occasion of the large and unusual haddock fishery that arose in the waters of South Jutland in the winter of 1925/26.—Visitors onboard were Dir. V. Lunn, Dr. R. Spärck and Dr. E. S. Russell from England.

Report 32, 1926, contains a paper by the present author: "On the Renewal of the Stock of Plaice in the Baltic proper". At the end of his last paper on the plaice population of the Baltic Dr. Petersen wrote these words in Report 31 of the Biological Station: "It would therefore be very desirable if before long the old important question of the renovation of the stock of plaice in the Sound and the Baltic in the years to come might be examined methodically over larger areas". Up to now an eager search for plaice fry of the year had revealed only quite a few individuals at the coasts of the Baltic whereas large quantities of such fry were found at the same time at the coasts of the Belts and the Kattegat. Consequently, it had formerly been supposed that the stock was maintained by an immigration from the Belts or the Kattegat. Later on, however, Dr. A. C. Johansen had shown partly that pelagic youngs of the plaice occurred in the Baltic, partly that the bottom stages of the 0-Gr. could be found in autumn in deeper water of the same place. He therefore supposed that the hypothesis of immigration must be given up and that the bottom stages in the Baltic, in contrast with other Danish waters, were found in deeper water. I now showed that a systematic search for the plaice fry of 1925 resulted in the finding of so numerous a 0-Gr. at the coasts of Bornholm and Sealand, that it equalled that of the neighbouring waters. The size of the 0-Gr. plaice taken by me at the coasts was inferior to the 0-Gr. plaice taken in deeper water, and I therefore considered it permissible to infer that the latter originated from the coasts and had immigrated into deeper water later on. In other words I arrived at the conclusion that the plaice population of the Baltic proper, as in the rest of our waters, is recruited from the young plaice growing up at the coasts. But the recruiting is very irregular, being ample in some years and almost nil in others.

Fig. 40. R. Spärck.

1926 was Dr. Petersen's last year as Director of the Biological Station. F. V. Mortensen, Superintendent of Fisheries, who had succeeded Comm. C. F. Drechsel as chairman of the "Kommissionen for Havundersøgelser" (The Commission for Sea Investigations), had long been endeavouring to simplify the administration of the fishery investigations problems. But Dr. Petersen was in no way inclined to give up his independence: for 37 years he—and he alone—had planned the nature and the extent of the investigations and decided on the use of the material. When the situation now came to such a point, that the Ministry drew up another instruction, which restricted his authority in this respect to a

Fig. 41. The laboratory in the "Japetus Steenstrup". Above to the left a tablet with dried fish, illustrating the growth of the plaice. Below a balance for weighings of bottom samples. To the left of the window a plankton net. H. Blegvad phot.

by a collaboration between the Biological Station and the Commission. The latter institution carried out the investigations that had been turned over to Denmark as a member of the International Council. As mentioned above, however, Dr. Petersen had withdrawn from the Commission already in 1909, and consequently the steamer of the Biological Station, "Japetus Steenstrup" and the research vessel "Dana" of the Council had been working independently of each other in Danish waters and sometimes—as cannot be denied—with the same considerable degree, he preferred to give in his resignation, which was granted on September 1st of the same year.

On August 30th, 1926 Dr. Petersen handed over the "Japetus Steenstrup" to the Superintendent of Fisheries by a short and plain ceremony at the Tuborg Harbour. There is hardly any doubt that it grieved Dr. Petersen to leave his life's work in this way, and it is characteristic of him that in spite of repeated invitations from my side he could never again be persuaded to pay a visit onboard the

steamer in which he had taken so great interest in former times. It must be said in justice, however, that in the work at the Biological Station it was a great advantage that it could now be carried out in collaboration with the Danish commission for the exploration of the sea and, particularly, that the Station once more took part in the exploratory work of the International Council. Most likely Dr. Petersen himself realized this; at any rate he never, during his last year, gave expression to any bitterness in front of me, his nearest collaborator, and I believe that it suited Dr. Petersen very well to leave at that point of time. During the last years he had to an increasing degree left the investigations to the present author, and his visits onboard had become rarer. His leisure time he mostly used for philosophical studies. Moreover his health was giving way: his heart sometimes failed, to his grief especially when he took part in shooting excursions, his favourite recreation. On his leave he was appointed Commander of Danebrog, a distinction which he valued most highly. He also received many demonstrations of honour from scientific circles: in 1927, for instance, he became an honorary member of Naturhistorisk Forening (the Danish Natural History Society).

Dr. Petersen was allowed to enjoy his leisure for little more than eighteen months. With his usual ardour he set on to studies of natural philosophy and managed to finish a book on the subject, "Om nogle biologiske Principper" (On some biological principles), which appeared at Prior's, Printer to the Court, in 1928. During this time he frequently conferred with Dr. J. Hjort and Dr. E. S. Russell, his two friends and colleagues, who were also much interested in natural philosophy.—On May 11th, 1928, Dr. Petersen died at his home in Amaliegade. With Dr. Petersen we lost not only the pioneer and leading man of Danish fishery biology, but also a great and single-minded character. From a modest beginning he had made the Danish Biological Station a highly esteemed institution, and his large contributions to the benefit of the fishermen as well as the international fishery biology was acknowledged both in this country and abroad. His name has thrown a lustre on the name of Denmark.

A. C. JOHANSEN

On September 1st, 1926, Dr. phil. A. C. Johansen became the successor of Dr. Petersen as Director of the Biological Station. Since 1902, when he was assistant at the Station, he had been working at the Commission for Sea Investigations, from 1909 as the leader of the investigations in Danish waters that had fallen to this country as a member of the International Council. During this time he had carried out a great and significant work, first and foremost concerning the plaice population of the Danish waters: he had started a regular examination on the quantities of young fish along the coasts with a special gear, "Johansen's young fish trawl", by means of which it became possible to follow the annual fluctuations. This method is still used and affords important information on the stock that will be available to the fishery in the years to come. He had also been working energetically to introduce a protection of the plaice both in the North Sea and the Kattegat, and it was a great disappointment to him that a plan for an international protection of the plaice of the North Sea, which was advocated by the International Council for the Exploration of the Sea, had to be abandoned, to begin with on account of the opposition of the English trawl owners. He had further found a correspondence between certain hydrographic dates and the fishings for mackerel and eel, and he had entered deeply into the problem of the races of herring.

In September 1926 experimental workings were made with the "pumping bottom sampler" invented by Prof. Martin Knudsen, and later on the usual investigations of the autumn were carried out in the Limfjord. In October the occurrence of herring larvae in the Sound and the Belts was examined.

Visitors onboard in 1926 were Dir. V. Lunn, Dr. Spärck, Dr. E. S. Russell, London, and Mr. Soot Ryen and Mr. Sievertson, both of Trondheim.

Assistants of Dr. A. C. Johansen were, besides the present author, cand. S. W. Fogh, cand. mag. (later Dr. phil.) Aage J. C. Jensen, Mag. sc. (later Dr. phil.) E. M. Poulsen and Mag. (later Dr. phil.) A. Bruun. Further Mag. sc. C. V. Otterstrøm, who for many years had assisted Mr. Løfting, Inspector of Fisheries, as a freshwater fishery biologist. When the latter retired the investigations concerning the freshwater fisheries, too, were assigned to the Biological Station.

In the spring and autumn of 1927 the works of the Station mainly dealt with quantitative investigations on the fry of herring in the Belts, the Sound and the Baltic; during the rest of the year

fishing experiments and bottom investigations were carried out in the Limfjord and the inner waters from the Skaw to Bornholm. From the small motor-boat belonging to "Kommissionen for Havundersøgelser", which boat was later taken over by the Biological Station, coastal examinations of plaice fry were made with the young fish trawl mentioned above. These investigations are still carried out every year.

Among the visitors onboard the steamer may be mentioned Dr. R. Spärck, Prof. Kolderup Rosenvinge, Mag., Mrs. E. Wesenberg-Lund, Mag. H. Ditlevsen and Dr. Altnöder, Berlin.

Report No. 33 of the Biological Station contains 4 papers, 2 of them by Dr. Johansen, "On the Fluctuations in the Quantity of Young Fry among plaice and certain other species of fish, and causes of the same" and "On a Spawning Place for winter spawning Herring in the northern part of the Belt Sea". The former paper brings the results of the quantitative investigations on the occurrence of plaice fry along the coasts of the southern Kattegat and the Belt Sea in the years 1904—26, compared to various hydrographical factors and to the amount of plankton. From these comparisons the author draws the conclusion that in cold winters when cold water that is poor in salt and plankton flows through the Belts and the southern Kattegat, very small quantities of plaice fry appear. The latter paper brings a survey of the results of the investigations on the occurrence of the herring larvae, more particularly of the investigations in March 1927 when tiny fry were found in the northern part of the Belt Sea, which thus must be supposed to contain the spawning place of a race of herring that spawns in the middle of January.

The third paper of Report 33 was written by the present author and termed "On the Annual fluctuations in the Age-composition of the Stock of Plaice". It is demonstrated that the 1921, 1923 and 1925 year-classes were numerously represented in the catches of both the Biological Station and the fishermen, so that these years must be supposed to have been good spawning years of the plaice in contrast to the intermediate years, and I recommend a raising of the minimum size-limit in the Belt Sea and the southern Kattegat.—The fourth paper, written by R. Spärck and termed "Studies on the Biology of the Oyster *(Ostrea edulis)* II—IV" consists of three small sections dealing with the feeding and growth of larval oysters, the nutrition of the grown-up individuals and the fluctuations in the oyster stock of the Limfjord, respectively. By experiments in tanks it was shown that oyster in a good state of nutrition will easily spawn even in rather small tanks, but that the oyster larvae are extremely difficult to feed artificially even if they are fed with unicellular green algae; attachments failed to appear during the experiments carried out. The second section deals with recent literature on the food of the oyster; the

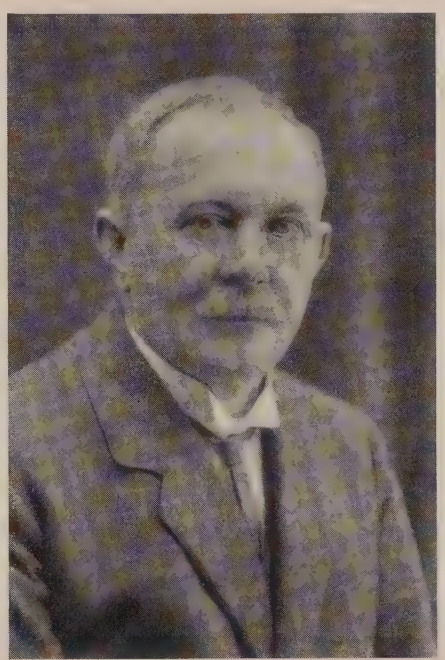

Fig. 42. A. C. Johansen. 1926.

author advances the view that in certain localities, particularly in small quantities of stagnant water, micro-organisms constitute the predominant food of the oyster. The last section is a comparison of the fluctuations in the yield of the oyster fishery at West Sleswick to that of the Limfjord, the congruence of these yields being good. The cause of these fluctuations must be changes in the climate, especially in the summer temperature: the natural mortality in the Limfjord may be estimated at at least 20 per cent. per annum, the diminution due to the fishery at only 6—8 per cent. annually.

TRANSPLANTATIONS OF PLAICE TO THE BELT SEA

The intense fishing in the Belt Sea, *i. e.* the waters round Funen and Seeland, had gradually thinned the plaice population to such an extent, that the yield

of the plaice fishery, in spite of the rapid growth of the remaining plaice, during the last years had decreased to a serious degree. Accordingly, the idea gained more and more ground that an attempt should be made to increase the plaice population of the Belt Sea by a transplantation of small North Sea fish in the same way as in the Limfjord.

Already in October 1926 Dr. Johansen had made some preliminary experiments in order to see whether the plaice used for transplantations in the Limfjord were able to live in the Belt Sea. A number of plaice from the Nissum Bredning were kept in fish ponds in different harbours of the Belt Sea waters for about a fortnight, and the mortality turned out to be very low.

After the favourable result of this experiment the first large-scale experimental transplantation of plaice to the Belt Sea was organized in April 1928. A total of 143,000 plaice were transplanted, the greater part of them originating from the Nissum Bredning in the Limfjord, the rest from the Horns Reef Area at Esbjerg. No less than 3,000 of these fish were marked at the places of liberation in 30 different localities; at the same time 430 plaice from the Belt Sea itself were marked.

Accordingly, the work of the Biological Station in April and May 1928 mostly dealt with these transplantations and markings. Besides this the Limfjord was examined several times both in spring, summer and autumn, also with a special view to the transplantations there, and experimental fishings were carried out in inner waters from the Skaw to Bornholm. In the autumn the occurrences of herring larvae were studied in the Belt Sea and the Baltic.—In the summer of 1928 the present author visited Lithuania on the invitation of the Lithuanian government for the purpose of making proposals for an organisation and modernization of the fisheries of that country.

Fig. 43. Oyster dredger in the Limfjord. H. Blegvad phot.

Prof. Siedlecki, Dr. Borowik and Dr. Bückmann, all of them experts of the International Council for the Exploration of the Sea, visited the Station in 1928.

The Report of 1928, No. 34 in the series, contains 6 papers. Dr. Spärck's "Studies on the Biology of the Oyster V" once more deals with the fluctuations in the size of the oyster population of the Limfjord. After the last counting of the stock in 1924 the oyster population of the inner Limfjord had been protected. A counting in 1927, made partly by divings, partly by experimental dredgings showed that the population of the protected area had suffered a further decrease, so that less than 5 mill. specimens of the native stock was supposed to be left in the summer of 1927. The author ends by emphasizing

that it is impossible to carry out a considerable oyster fishing for a long series of years basing only on the natural stock of oyster in the Limfjord without a relaying.—Mag. Å. J. C. Jensen's "Remarks on the Hydrography of the Limfjord" give an account of the hydrographical conditions of this water, basing principally on investigations in 1927. Among other things he shows that the renewal of the bottom water of the remote broads takes place at inter-

Fig. 44. The fishing boats arrive with plaice for the transplantations to the well-boats in the Limfjord (Nissum Bredning). S. Fogh phot.

vals and particularly during unstable conditions of weather.—A paper by the present author, "Quantitative Investigations of Bottom Invertebrates in the Limfjord 1909—1927 with Special Reference to the Plaice-Food" deals with the results of the bottom samplings in the years between 1918 and 27. I show that in the different broads of the Limfjord there are great fluctuations from year to year in the amount of fish food, but in the years 1924—27 there was extremely little plaice food on the bottom of the whole Limfjord. At the same time rapidly increasing amounts of *Zoarces* and *Gobius* were observed, and I show that this is connected with the occurrence of cod: in years with many adult cod in the Limfjord there are few *Zoarces* and *Gobius* and *vice versa*. As *Zoarces* and *Gobius* are food competitors of the plaice, I find it most probable that these two species of fish are responsible for this very marked decrease of the food amount on the bottom.—Dr. A. C. Johansen writes on "The Extent of the Annual Transplantations of Plaice in the Limfjord and the Yield resulting therefrom". In comparing the statistics of the yield of the plaice fishery with the quantities of plaice transplanted to the different areas throughout the years he arrives at the conclusion that the heaviest returns of the transplantations occur in the Thisted Bredning, to which there is almost no natural immigration; but during later years the yields of all areas have decreased as compared to the amounts of fish transplanted. The cause of this, according to the author, is the intense fishing by means of gill-nets, eel-seines and pound-nets, by which a great number of the undersized fish transplanted are lost. In calculating the size of the plaice population of the Nissum Bredning he arrives at figures ranging between 17 and 76 mill. specimens. An examination of the density of the stock as compared to the yield per 1 hectare shows that there is a maximum value of the yield by a medium density of the stock and a minimum value by a maximum density as in the Nissum Bredning;

it is even possible that a removal of fish for transplantations from this area has had a favourable effect on the stock. The author concludes by recommending an increased transplantation to the Thisted Bredning, a raising of the minimum size-limit in the western part of the Livø Bredning and in the Sallingsund, and the prohibition of the use of gill-nets in the transplantation areas during the first months after the transplantation.—A paper by Å. J. C. Jensen on "The Relation between the Size of the Plaice Stock and the Quantity of "First Class Plaice-Food" in certain Parts of the Limfjord" examines the correlation between the amount of plaice food and a number of other factors. According to the author no connexion can be established between the amount of food and the yield of the fishery in the Thisted-Visby Bredninger, but in other parts of the Limfjord (District B) he finds a connexion between the quantity of food in autumn and the catch yield of the natural stock of plaice. He also finds a positive correlation between the production of plaice per 1 ton of fish transplanted to the Thisted-Visby Bredninger and the surface temperature at Oddesund in October, and between the latter and the catch yield of the natural stock of District B.—The last paper of Report 34 is by Mag. E. M. Poulsen and is termed "The Haddock in the Belt Sea and the Western Baltic during the years 1926—28". The author has analysed samples of the unusually large quantities of haddock that entered the Belt Sea from the north as larvae in the spring of 1923 and gave rise to a considerable haddock fishery in 1925—28. He shows that the haddock thrives very well in the Belt Sea where the growth is even more rapid than in the North Sea and at Iceland. But the haddock cannot breed here: though some of the haddock in the Belt Sea in 1927 undoubtedly spawned here, no larvae developed from the eggs. In other words the occurrence of haddock in the Belt Sea depends on an immigration of larvae from the north with a strong inflow of salt water during the period immediately after the spawning time of the haddock in spring and early summer.

Fig. 45. Well-boat carrying plaice for the transplantation in the Belt Sea. H. Blegvad phot.

HERRING INVESTIGATIONS

The work of the summer of 1929 was continued on the same lines as in 1928: in spring markings of plaice during the transplantations, in autumn investigations on the amount of herring larvae in the Belt Sea and the Baltic, and during the rest of the time fishing experiments and valuations in the Limfjord and the other Danish waters inside the Skaw.

Visitors onboard were *i. a.* Prof. Brühl, Berlin, Mag. Mrs. Wesenberg-Lund and Dr. E. Fischer, Berlin.

Report No. 35, 1929, includes 4 papers. In his treatise on "The Aalborg Herring and its Importance in the Danish Herring Fishery from the XVIth Century until the Present Day" Dr. A. C. Johansen gives an account of the Limfjord Fishery in the middle ages and shows that the large herring fishings took place only in the eastern part of the Fjord and that the yields were subject to great fluctuations. After 1829 these fishings sank into nothingness. By an examination of the racial character the author shows that the Aalborg herring is now caught over the greater part of the Limfjord. Only in the western region another spring spawning race is found, which the author calls Thyland's spring herring. Moreover, two races of autumn spawning herring enter the Limfjord, mostly, however, as young herring ("silding"). The author assumes that the Aalborg herring during a considerable part of the year stays in the Skagerak in order to eat, as is the case with the bank herring of the North Sea and the autumn and winter her-

rings of the Kattegat. He further emphasizes that an intense fishing for herring in the Limfjord and at the west coast of Jutland, in contrast to conditions in the Belt Sea and the western part of the Baltic, involves no danger to the herring.

The second paper of Report 35, "Mortality among Animals of the Littoral Region in Ice Winters" was written by the present author. During the severe winter of 1928—29 many animals of the littoral zone the moon and the spawning of the oyster in the Limfjord; the old oyster seem to be the first to spawn, the younger individuals following later on. The second paper deals with the influence of the temperature and the absorption of oxygen in the tiny oyster larvae, the third one with the natural mortality in the oyster stock; there is a high summer mortality but a rather low winter mortality in the Nissum Bredning as opposed to the inner broads.

Fig. 46. The marking of the plaice. S. Fogh phot.

died, especially those which were directly exposed to the effects of the cold during ebb-tide: *Mytilus edulis*, *Cardium edule*, *Mya arenaria* and *Arenicola marina*.

Dr. A. C. Johansen discusses a similar subject in his paper "Mortality among Porpoises, Fish, and the larger Crustaceans in the Waters around Denmark in Severe Winters". The author had gathered information on this matter from various sides, and it turned out that both porpoises and many different kinds of fish had died from cold in the winter of 1928—29; also part of the crabs, lobsters and shrimps had become victims of the cold.

At the end of Report 35 we find 3 small papers by Dr. R. Spärck under the common title of "Studies on the Biology of the Oyster (*Ostrea edulis*) VI—VIII". In the first paper the author says that he has found no connexion between the phases of

INVESTIGATIONS ON POLLUTION

Also in 1930 the work of the Biological Station was continued on the lines of previous years. In some fjords of East Jutland, for instance the Horsens, Vejle and Kolding Fjords investigations were made concerning the influence of the sewer outfalls on animal life. These were the first investigations on pollution carried out in salt water by the Biological Station. We little knew at that time that investigations on pollution in the years to come would enlarge to such an extent, that the staff of the Station had to be increased in order to manage the work in such cases. During the summer the present author with kind assistance from the Navy Department carried out experiments of spotting fish shoals from aircrafts.

Visitors during the summer of 1930 were *i. a.* Adjunkt Otterstrøm, Mag. H. Ditlevsen and Prof. Brühl.

BOTTOM ANIMALS AND FISH FOOD, SPRAT, MACKEREL AND FLYINGS

Report No. 36 of the Station appeared in 1930. It contains 4 papers. In the first of them, "Quantitative Investigations of Bottom Invertebrates in the Kattegat with Special Reference to the Plaice Food", the present author discusses the results of the valuations in the Kattegat as compared to the stomach analyses of plaice of the same water. I show that the plaice are rather particular in their choice of food. During their first time the 0-Gr. plaice live on small crustaceans, especially copepods, after that on small bivalves and worms. In their second year of life they principally feed on chaetopods and bivalves. Besides the animals mentioned ("1st class plaice food") the older plaice eat some larger bivalves and crustaceans, which can be turned to use only by such larger plaice and are therefore termed "2nd class plaice food". In calculating the amounts of bottom animals of each of these two categories found during the valuations I arrive at the result that in the Kattegat the annual production of "1st class plaice food" alone is so great, that it would suffice to maintain 6 times as many plaice as those found at present in the Kattegat. I therefore think that a protection of the nursery grounds along the east coast of Jutland will be a rational measure.

The second paper is by Dr. A. C. Johansen and deals with "The Sprat (*Clupea sprattus* L.) in the Limfjord". Eggs of sprat were found in large quantities all over the Limfjord in May 1930, most of them in the central part. In other words the sprat spawns in the Limfjord, and racial investigations show that it is found as a special Fjord race here. It attains an age of at least 3 years.

Fig. 47. H. M. 99, flying boat of the navy, used for spotting of fish shoals. H. Blegvad phot.

In the third paper, "On the Influence of hydrographical Factors upon the Yield of the Mackerel Fishery in the Sound" by Aage J. C. Jensen, the correlation is examined between certain hydrographical and meteorological conditions and the yield of the mackerel fishery in the Sound. A connexion is shown to exist between the last named in September and the surface temperature of the water in the same month, so that a heavy yield is obtained in the years in which the water is comparatively cold, and *vice versa*. The connexion with the temperature of the water has, during the later years, turned out to be less pronounced, whereas later investigations have shown that there is a distinct connexion between the yield of the fishery

and the dominance of northwesterly winds in May when the mackerel enter the Sound. This connection may possibly be used for forecasts.

The last paper of the Report, "Aerial Spotting of Fish Shoals. Danish Experiments in 1930" was written by the present author. From a flying boat belonging to the navy I tried to track shoals of herring and mackerel from the air. Flyings were made over the Kattegat, the Great Belt and the Sound,

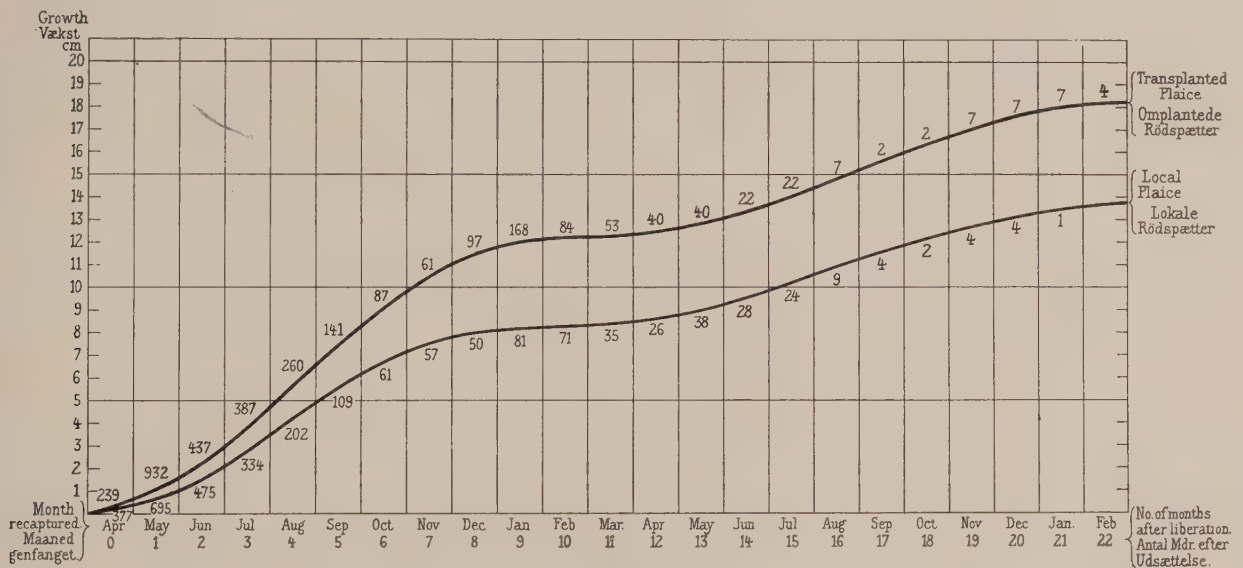
Growth
Vækst
cm
Transplanted Plaice
Omplantede Rödspætter
Local Plaice
Lokale Rödspætter
Month recaptured
Maaned genfanget
No. of months after liberation.
Antal Mdr. efter Udsættelse.
Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan. Feb
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
239 932 437 387 260 141 87 61 97 168 84 53 40 40 22 22 7 2 2 7 7 7 4
177 695 475 334 202 109 61 57 50 81 71 35 26 38 28 24 9 4 2 4 4 1

Fig. 48. Growth of transplanted North Sea plaice in the Belt Sea and of local Belt Sea plaice. From Report No. 39.

but the weather was rather infavourable, and only one shoal of mackerel was observed. But the experiment showed that the method was adaptable to the purpose, and so I conclude by recommending a continuation.

THE DEATH OF DR. A. C. JOHANSEN

Already at a previous point of time Dr. Johansen had had to undergo an operation for a bilious complaint. The disease was complicated with a gastric ulcer, which for periods forced him to keep his bed. From his sick-bed, however, he was able to lead the work of the Station and to confer with his collaborators, and his interest in the investigations was constantly strong and living. But in the spring of 1931 it became necessary to carry out another operation, which he did not survive; he died on May 13th.

His great work in the service of the fishery biology was commemorated above. I want to add in this place that Dr. Johansen was a distinguished personality and equally popular with the fishermen and his colleagues and collaborators. He was unostentatious and straightforward, and under his leadership the Biological Station came into much closer contact with the fishermen of the country than had been the case under the leadership of Dr. Petersen. He possessed an untiring industry and energy, and a comprehensive knowledge and an accentuated critical sense marked all his scientific works. To the Danish fisheries his work on the biology of the plaice and the races of herring and his initiative in starting the transplantations of plaice to the Belt Sea have been of such an importance, that his name will go down to posterity.

In 1931 the work from the "Japetus Steenstrup" began already in March with quantitative investigations on herring larvae in the Belt Sea. In early spring numerous markings of plaice were carried out in connexion with the transplantations to the Belt Sea, which were resumed on a large scale in 1931 after a pause in 1930. Besides the usual stock analyses in our waters from the Skaw to Bornholm a series of investigations on the pollution were carried out in the Sound and the Roskilde Fjord. In the latter

investigations the Station was aided by I. A. van Deurs, Civ. Eng., who in 1930 had become leader of the newly erected Fiskeriøkonomisk Forsøgslaboratorium (the name of which was later altered into Fiskeridirektoratets Forsøgslaboratorium); down to his death in 1942 he also frequently assisted in the investigations on pollution carried out in fresh waters, mostly by Mag. C. V. Otterstrøm. The experiments on the localization of fish shoals from the air were also continued in 1931.—On July 1st the present author succeeded Dr. Johansen as Director of the Biological Station. In the spring of the same year Mag. sc. E. M. Poulsen had won his doctor's cap for a thesis on the biology of the cod, printed in Meddelelser fra Kommissionen for Danmarks Fiskeri- og Havundersøgelser. On September 1st he was appointed assistant of the Station.

Fig. 49. The "Biologen", the new steam-ship of the Biological Station to the right. To the left the old steamer "Japetus Steenstrup". The Aalborg Shipyard, July 1932. H. Blegvad phot.

THE STATION GETS A NEW STEAM-SHIP, THE "BIOLOGEN"

Broadly speaking the works of the summer 1932 was continued on the same lines as in the times of Dr. Petersen and Dr. Johansen, including the regularly repeated investigations on the quantities of herring larvae and of young plaice at the coasts, the valuations, the stock analyses in various waters and the control of the transplantations. In the salt water the examinations into the pollution in 1932 were extended to the Saxkøbing Fjord.

Among the new tasks special importance must be assigned to the transplantations of cod to the Limfjord, which were started in 1932 and continued for the next two years. The cod, which were taken in the Kattegat, were small individuals of about 33 cm, and they proved to grow excellently, but it turned out that much too large a number of them were captured immediately after their liberation. Furthermore, a natural immigration of small cod took place in the autumn of 1935, and so the transplantations were stopped.

Already during the directorship of Dr. Petersen several attempts had been made to have the small and old steamer of the Station, which was built in 1873, replaced by a larger and more modern boat. Drafts had even been made for a new construction, but the plans had repeatedly been shelved. After a great preliminary work and particularly through the assistance of F. V. Mortensen, the Superintendent of Fisheries, we finally managed to get a government grant for a new steam-ship in the spring of 1932. There had been some talk of building a motor-ship, but this was given up on the following grounds: the vibrations from the motors in a comparatively small vessel like the present one would mean a con-

siderable inconvenience in the work onboard; a lengthened range of action was of no interest because the ship was meant to work Danish waters only; finally, the adjustment of the engines for different degrees of slow rate during fishery is easier and simpler in a steam-engine than in a motor.

were invited to join in the trial trip in the Sound and expressed their enthusiasm for the new vessel.

The "Japetus Steenstrup" had had a crew of 6 men, but the new, larger vessel demanded a greater crew. Captain was H. C. Christensen, who had been mate of the "Dana" and had navigated her during

Fig. 50. S/S "Biologen" leaves the harbour of the Skaw. Jonals phot.

The new steam-ship of the Station (Fig. 50), which was given the name of "Biologen" (*i. e.* "The Biologist") was launched at the Aalborg Skibsværft on July 5th, 1932. It is 143 tons gross or nearly 3 times as big as the old steamer; its draught, however, is only 2.5 m, so that it is able to work in comparatively shallow water. The ship is fitted with echo sounding, electric winch, thermograph and other modern instruments, so that the Station now has at its disposal an absolutely modern research-vessel.

The "Biologen" was handed over by the shipyard in September 1932 and at once came into use. A number of scientists, among whom were Dr. Th. Mortensen, Prof. Martin Knudsen and many others

part of her voyage round the world in 1928—30. N. Johansen, the former captain of the "Japetus Steenstrup", became fishing master and mate of the new vessel. L. P. Larsen, the former mate, on $^1/_{10}$ 1932 took his leave on account of an increasing deafness, but remained with the Station as a laboratory assistant. The chief engineer, stoker, steward and sailor all went into the new vessel; besides, Johs. Dahl was made regular sailor from October 1st; he had been working onboard the old vessel since 1927 as a relief of Ahlmann Andersen, whose health had declined. For the cruises of every summer were further engaged a hand for the deck and a boy, so that the crew now consisted of 9 persons.

THE POLLUTION OF THE SOUND

Report No. 37 of the Biological Station appeared in 1932 and contains no less than 8 papers. Two of them deals with the pollution of the Sound, viz.: "Investigations of the Bottom Fauna at Outfalls of Drains in the Sound" by the present author and "Hydrographical Investigations of the Pollution of the Sound at Copenhagen" by Aage J. C. Jensen. The former gives the result of a series of inves-

Fig. 51. Bottom animals are sorted out from a bottom sample in the laboratory of the "Biologen". Jonals phot.

tigations with the bottom sampler at the outfalls of drains; it turned out that only a comparatively small area in the immediate vicinity of the outfalls possessed no animal life. Already at distances of 1—200 m there was a rich bottom fauna, often even with remarkably well-fed polychaetes and many bivalves. In other words the pollution of the bottom is not damaging to the bottom fauna as a whole.— The latter paper deals with the hydrographical conditions near the drains. It is shown that the content of oxygen would fall rather low in certain localities, but generally speaking the sewage did not reduce the oxygen content of the sea water to such an extent, that it influenced the animal life in a harmful way.

In a paper by E. M. Poulsen, "Analyses of Stock and Race of the Baltic Plaice during recent Years", we are informed that countings of fin rays seem to show that a considerable immigration of plaice into the Baltic takes place, at any rate in certain years. Dr. R. Spärck writes about the oyster. In the treatise "On the Size of the Stock of Native Oyster" he demonstrates that there has been a further decrease of the native stock since the last countings in 1927. In a "Preliminary Investigation of the Content of Bacteria in the Limfjord Oyster" by R. Spärck and E. Lange it is shown that a pollution of the Limfjord oyster is out of the question. Dr. Spärck further reports on "The Capacity of Migration of Adult Individuals of *Asterias rubens*"; in the Limfjord these migrations seem to be comparatively insignificant. The present author has written the last two papers of Report 37: "On Aerial Spotting of Fish Shoals. II. Danish Experiments in 1931" and "Preliminary Report on the Danish Experimental Transplantations of Plaice from the North Sea to the Belt Sea during the Years 1928—31". In the former I account for the results of the experiments of spotting fish shoals from the air, carried out by the author in September 1931 with the renewed kind assistance of the naval authorities. It proved to be possible to localize shoals of herring and mackerel, but they were so few and small, that it will hardly pay to organize a rational search for the shoals in this country by means of aircraft.—In the latter paper I give the results of the previous experimental transplantations, based on the markings of the fish transplanted, as they were carried out by the Biological Station, and on other control works. The growth of the plaice transplanted turned out to be extremely rapid—about 12 cm during the summer, and about $^1/_3$ of the fish that had been marked during the transplantation were recaptured. The total value of the transplanted fish recaptured by the fishermen is estimated to range between 100,000 and 157,000 Kr. by an expenditure of 50—60,000 Kr. I conclude by advocating the introduction of a period of protection of the transplanted fish or a raising of the minimum size-limit.

THE DISEASE OF THE EEL-GRASS. INVESTIGATIONS ON THE COMMON DAB

In 1933 the disease of the eel-grass began to make itself felt. The vast vegetations of the Limfjord, the Kattegat and the Belt Sea disappeared, the leaves growing speckled, later black, and then sinking to

the bottom. Investigations and inquiries in different localities showed that the first appearance of the disease was in the spring of 1933 in the Limfjord and at Frederikshavn, from where it had spread southwards where some fresh eel-grass was still found in the Sound and S. of Seeland and Funen (Fig. 54). The character of the disease was studied by Dr. Henning E. Petersen, the botanist, who got his material from the Biological Station (cp. later under the mention of Reports 39 and 40).— Besides the continuation of the usual stock analyses etc. in all Danish waters from the Skagerak to the eastern Baltic investigations were made concerning the pollution in the inner region of the Odense Fjord and that caused by the sulphuric acid factories at Aalborg. Furthermore, a show of fishery biology was arranged at "Nordjysk Udstilling" (the North Jutland Exhibition) at Aalborg, where tablets and preparations illustrated the results of the works of the Station: the growth, migrations and food of the different species of fish, the valuations, transplantations, etc. Such exhibitions had already been arranged in a few other localities, *i. a.* in Copenhagen (the exhibition "The Sea") and had roused considerable interest. Also in the following years similar exhibitions from the Biological Station were held in many different towns (Fig. 55), and there is no doubt that this has contributed highly towards making the work of the Station known in wider circles, also among the fishermen.—Among the scientists visiting the Station in 1933 may be mentioned Jussuf Kemal, Superintendent of Fisheries in Stamboul, Prof. O. Carlgreen, Lund, Prof. Lønberg and Dr. A. Molander, Lysekil, Dr. K. A. Andersson, Stockholm, Dr. R. Spärck, Trolle Thomsen, Inspector (later Superintendent) of Fisheries, Capt. K. Nellemose, Mr. v. Deurs, Civ. Eng., M. Højgaard, undergraduate (later Mag. sc. and Director of Danmarks Akvarium) and cand. mag. Stubbe Teglbjerg.

On April 1st, 1933 Ahlmann Andersen had to take his leave as a sailor, after nearly 18 years of service, on account of an increasing delicacy of health. From the same date he was succeeded as sailor by Svend Nielsen. Ahlmann Andersen, however, remained in the service of the Station as caretaker of the transport at Nyborg, and in spite of his constantly increasing physical weakness, which he only overcame by an unsubduable energy of will, he rendered a most valuable help to the Station until

Fig. 52. Onboard the "Biologen". Measuring of the fish. Jonals phot.

he died in 1938, only 42 years old. He was a man of unusual intelligence, coupled with great mechanical skill, and he took a fervent interest in the work of the Station. Like L. P. Larsen, the former, now pensionary mate of the Station, he had during his work at the Station gradually learned the Latin names of the bottom animals of the Danish waters.

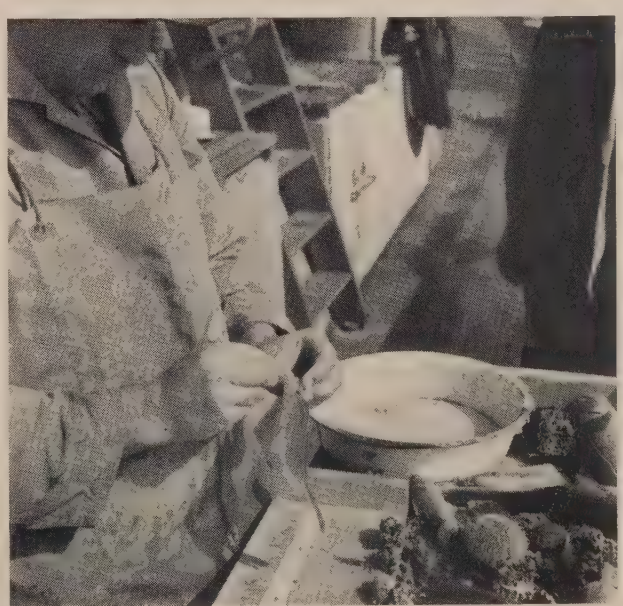

Fig. 53. Onboard the "Biologen". The otoliths are removed from the plaice. Jonals phot.

Fig. 54. Map showing the spread of the eel-grass disease in 1933. The hatched regions denote the areas from which the eel-grass has disappeared; in the dotted regions it was still found to be green.
The picture showed no great changes during the following 10 years.
From Report No. 39.

Fig. 55. Part of the exhibition of the Biological Station at Næstved. 1935. Arnholtz phot.

It often happened that foreign scientists visiting the Station were astonished and impressed by the knowledge of these two men.

In the autumn of 1933 Mag. Aage J. C. Jensen had won his doctor's cap for a thesis on the periodical variations in the size of the various stocks of fish. It was printed in "Meddelelser fra Kommissionen for Danmarks Fiskeri- og Havundersøgelser".

Report No. 38 of the Biological Station appeared in 1933. The present author gives a description of the "Biologen", the new research-vessel of the Station, accompanied by many pictures. Dr. E. M. Poulsen reports on the "Biology of the Dab in Danish Waters", describing how the fishing for this species in later years has increased coincidently with the numerical decrease of the plaice population and illustrating its distribution, racial characters, growth and breeding habits. As compared to the plaice the dab is a rather slowly growing fish, and as it is a competitor of the plaice for food, the author recommends to show some caution in introducing protective measures as regards the dab. In his "Investigations on the Biology of the Oyster. X." Dr. R. Spärck delineates the results of preliminary investigations on the power of filtration in *Ostrea edulis*. In absolutely quiet water it turned out that even the ciliary motion of a 5-year-old oyster would not bring about the mixing of two layers of salt water at a distance of 5 cm. This explains why the oysters in stagnant water often die from starvation, so that they will thrive only in localities with a pronounced motion of the water.

THE RESULTS OF THE TRANSPLANTATIONS TO THE BELT SEA. POLLUTIONS IN FRESH WATERS

Also in 1934 there was a methodical continuation of the investigations from the "Biologen"; cod and plaice were transplanted to the Limfjord and plaice to the Belt Sea. These transplantations had roused great attention abroad, and professionals arrived

from Sweden, Norway and Germany in order to study our methods. Gradually all these three countries began to transplant plaice to their respective waters. In Norway small plaice were transplanted for several years to the Oslofjord, to which place they were carried in well-boats from Thyborøn, and in April 1934 Dr. (later Professor) Johan T. Ruud visited the "Biologen" at Thyborøn in order to study our methods and prepare the transplantations to the

Fig. 56. From the exhibition in Brussels 1935. To the left an illustration of Denmark's rising share in the North Sea plaice fishery in the years before 1935. To the right a representation of the transplantations of plaice to the Belt Sea; below a plaice of average size at the transplantation in April; above this a plaice, caught 8 months after the transplantation in the Belt Sea. H. Blegvad phot.

Oslofjord; according to later reports these transplantations seem to have yielded good results. Other visitors of the Station were Mr. John M. Bass, Director of the Bass Biological Station, Florida, and Mr. Zinn from the same institution, M. le Président Th. Tissier and Dr. le Danois from L'office des pêches maritimes at Paris and Prof. Ch. Pérez, Director of the Zoological Station of Roscoff and Professor at Sorbonne. Danish visitors were Mr. Villars Lunn, Director, Dr. R. Spärck, Mag. G. Thorsson and cand. mag. Ussing.

As mentioned above the examinations into pollutions of our fjords and sounds had already been carried out for several years by the Biological Station; in 1934 similar investigations in our fresh waters began to increase rapidly. § 14.2 of the Freshwater Fisheries Act, according to which a fishery expert, appointed by the Ministry of Agriculture and Fisheries, must join every court that is formed in cases of now outlets of waste water, had hitherto practically been disregarded by the authorities, so that a lot of cases concerning waste water had formerly been settled without any regard being paid to the fisheries. The result had been an extensive pollution of many of our fresh waters. Now the Biological Station gradually carried through a campaign for the purpose of having the said paragraph respected, which of course gave much more work to the staff of the Station, especially to Mag. C. V. Otterstrøm, Assistant in questions of freshwater biology, who had to examine the cases, draw up reports and attend the sessions of the various courts trying the water privileges.

To begin with especially the potato flour factories and the meat fodder factories with their great and dangerous outlets of organic matter into the streams gave rise to the forming of agricultural commissions under the co-operation of fishery experts; but gradually also the common drainings came to be dealt with, and the number of cases was growing year by year: in 1934 experts from the Biological Station assisted in 3 cases only, but in 1938 they had risen to 15, and their number is constantly growing. However, the importance of an expert

assistance in cases dealing with water privileges is gradually dawning upon the members of the courts, particularly after a circular from the Ministry of Agriculture and Fisheries to all judges and chairmen of boards of surveyors in 1936 had enforced the necessity of observing the directions of § 14 in the Freshwater Fisheries Act. In all hearings of cases connected with the interests of the fisheries a certain praxis has now been created, a fact that has proved to be of great importance in the efforts to counteract the pollution of our fresh waters.

Fig. 57. Fishing boat with sprat trawl, Kolding Fjord. H. Blegvad phot.

Report No. 39, 1934, of the Biological Station contains two papers, both of them by the present author. The first of them, "An Epidemic Disease of the Eel-Grass (*Zostera marina* L.)" describes the spread of the said disease in Denmark in the autumn of 1933. The disease seems to have arisen at the Atlantic coast of North America in 1930; in the winter of 1931—32 it had spread to the whole Atlantic coast of France, and in 1932 the vegetations at the coasts of Holland and England were attacked. In the spring of 1933 it was first discovered in the northern waters of this country, but during the summer it spread in a southward direction.

In the second paper, "Transplantations of Plaice from the North Sea to the Belt Sea 1928—33. The Scientific Survey" an account is given of the results of the transplantations through 6 years judged by the markings of the fish and by examining the catches of the fishermen of the Belt Sea. It is shown that 98 per cent. of the marked North Sea plaice were recaptured within the areas of liberation, that a great part of them attained maturity here and that their growth by far exceeded that of the local Belt Sea plaice. The pecuniary profit of the transplantations is estimated to be between 64,000 Kr. (calculated from the markings) and 168,000 Kr. (calculated from analyses of the catches of the fishermen). I conclude by recommending a 2 months' period of protection inside the areas of transplantation and a raising of the minimum size-limit.

By a collaboration between the Danish and Swedish fishery authorities and fishery biologists a transplantation of plaice from the Thyborøn to the west coast of Sweden was started in the spring of 1935, and the transplantations to the Oslofjord were continued. Also in Germany rather large-scale transplantations from the North Sea to the western Baltic were carried out in 1934 and the following years. All these works were no doubt prompted by the successful Danish transplantations.

EXAMINATIONS INTO THE HARMFULNESS OF NEW GEARS. SALMON AND SEA TROUT

Besides the usual analyses of stock in the different waters and the surveyings during the transplantations

the work of the Biological Station in 1935 involved investigations on the disease of the eel-grass and the harmfulness of the sprat trawl; this gear proved to be rather harmless to flat-fish and cod, and the use of it was allowed for a limited period of the year.

Among the visitors of the Station were Dr. Kändler, Kiel, cand. J. Hovy, Utrecht, Mr. V. Morevskis, Latvia, Mr. M. W. Cieglewiecz, Gdynia, Mr. Finsing, Editor of Holbæk, Mr. C. N. Hauge, the then Minister for Shipping and Fisheries and Mr. C. Trolle Thomsen, who had now succeeded F. V. Mortensen as Superintendent of Fisheries.

Fig. 58. The sprat trawl is hauled in from the "Biologen". H. Blegvad phot.

Report No. 40 of the Biological Station appeared in 1935 and contains 4 papers. The first of them, by Henning E. Petersen, "Preliminary Report on the Disease of the Eelgrass (*Zostera marina* L.)" gives the result of the investigations of the author on the disease. He arrives at the conclusion that the disease is caused by a fungus, which is described and pictured. In the second paper, "Recent Investigations into the Stock of Salmon and Sea Trout in the River Gudenaa" E. M. Poulsen describes how the barrier against the ascent of salmon and trout existing since the erection of the Tange Generating Station in 1920, has caused an enormous decrease in the catches of these two species of fish. After an account of the growth and state of nutrition of the sea trout he discusses the means by which to restore the stocks of salmon and sea trout: he proposes to raise the minimum size-limit from 37 to 45 cm, to restrict the wheel and pound net fisheries in and at the Randers Fjord, to improve the conditions of ascent at Tange and to increase the liberation of fry artificially hatched.

Report 40 further contains 2 smaller papers by R. Spärck: "Investigations on the biology of the oyster. XI. On the size and age-composition of the stock of native oyster in 1935" and "On the occurrence of *Crepidula fornicata* (L.) in the Limfjord". The former tells of a considerable spat-fall in great areas of the Limfjord in 1932 and 1934, so that a rise may be expected to take place in the natural stock of oyster. The latter reports that the gastropod *Crepidula*, which is a noxious animal on the oysters of England and Holland, has been found on oysters in the Limfjord. There is hardly any doubt that it has arrived there with oysters imported from Holland.

In 1936, besides the usual works, an examination was made into the problem whether fishing for eel with the otter seine should be allowed in the Limfjord. A great number of fishing experiments were carried out with this gear, which the majority of the fishermen had earnestly desired to be allowed to use in the Limfjord. The otter seine proved to be excellently suited for the catching of eel in this water, and it could not be said to hurt the stock of other food fishes when it was used in the right manner. By way of experiment it was therefore allowed to use the gear with certain restrictions. Whether the eel population of the Limfjord will be able to survive the intensified fishing in the long run is another question, which we shall not be able to answer until a longer period has lapsed.

Among the visitors of 1936 were Dr. H. Thamdrup, Dr. Spärck and Prof. O. Steinböck of Graz.

In the autumn of 1936 the present author went to Iran on an invitation from the Iranian govern-

ment in order to make fishery investigations in the Iranian Gulf. A North Sea fishing cutter, bought by the Iranian government, and three Danish fishermen at the same time started for the Gulf onboard a German steamer. The investigations were carried out in the winter season of 1936/37 from the cutter, which measured 34 tons, and were resumed in the winter season of 1937/38. As a result of the investigations a proposal was made to the Iranian government to the effect of erecting a canned goods and a fish-flour factory at Bender Abbas in the Straits of Oman and of engaging the necessary number of experts and fishermen to lead the factory and teach the Iranian fishermen the use of modern fishing gears. This proposal was accepted by the government, which submitted the building of the factories to A/S Atlas, Copenhagen; besides this 4 Danish experts were engaged to lead the factories, and 6 Danish fishermen were likewise engaged, and another Danish fishing boat was purchased. This cutter was

Fig. 59. The garden of Villa "Eltham". H. Blegvad phot.

Fig. 60. From a meeting of marine investigators at Villa "Eltham", 1935. H. Blegvad phot.

sailed by the Danish fishermen on its own keel from Esbjerg to the Iranian Gulf in the spring of 1940. —During my absence from November 1936 to June 1937 and from November 1937 to June 1938 Dr. E. M. Poulsen was substituted as director of the Station.

ANIMAL COMMUNITIES IN THE DYBSØ FJORD.—PRODUCTION OF MATTER IN THE ALGAE

Report No. 41, 1936, of the Biological Station contains 2 papers, the first of which was written by cand. Knud Larsen, who in 1934 had been attached to the Biological Station as the assistant of Mag. Otterstrøm. Under the title of "The Distribution of the Invertebrates in the Dybsø Fjord, Their Biology and Their Importance as Fish Food" it describes the animal community of the Dybsø Fjord in Smaalandshavet at Karrebæksminde. Besides a comparison is made between the quantitative amounts of animals in the Fjord and the stomach contents of the fishes.—The second paper was written by Mag. Søren Lund and termed "On the Production of Matter and the Growth in some Benthic Plants". After a mention of previous investigations on this subject the author describes the results of some experiments by which he determines the production of matter in and the weight of the marine algae by means of concrete blocks that were lowered into the sea and from the sides of which the vegetation was scraped after a fixed period. The weight amounts proved to differ widely from one locality to the other, the largest figures, 99.4 g per 1 m^2, occurring in the Lesser Belt, the smallest, 1.34 g per 1 m^2, in the Sound at Saltholm. Furthermore, information is given on the growth of some individual plants of *Fucus vesiculosus* at Saltholm in the Sound, and on vegetations on lighted buoys in the same water.

Fig. 61. The Charlottenlund Castle.

The investigations of 1937 mostly went on the same lines as before. As a special investigation may be mentioned the problem whether the fishing for the so-called "Skidtfisk" (poor fish), *i. e.* fishes that are unfit for human food and which are sold to the fish flour factories or to the trout ponds, may be supposed to influence the stocks of food fish in a harmful way; so far this seems to have been out of the question. It was further examined whether the comparatively new fisheries for *Pandalus borealis* and *Nephrops norvegicus* have caused a decrease in the size and quantity of these crustaceans; this proved not to be the case.

Of visitors onboard the journal mentions Mr. Finsing, Editor, Prof. R. Spärck and Dr. A. M. Hemmingsen.

THE BIOLOGICAL STATION IS REMOVED TO THE CHARLOTTENLUND CASTLE

During the first years of Dr. C. G. Joh. Petersen the transport was the only laboratory of the Biological Station. In winter the director had to carry out the scientific work at his home in Copenhagen, and the assistants were engaged for the summer term only. The Station had no fixed laboratory of its own until 1910, when a small 3-roomed flat was rented for this purpose at Willemoesgade in Copenhagen. Here the assistants worked in winter, assisted by one of the crew of the steamer while Dr. Petersen mostly preferred to work at home.

It was a great change for the better when, in 1926, on the succession of Dr. Johansen as director of the Station, the fixed winter laboratory of the Station was removed to Villa "Eltham" at Strandvejen 34B, Hellerup. This villa was rented by "Kommissionen for Danmarks Fiskeri- og Havundersøgelser" and, besides the various branches of the commission, contained the head-office of the International Council, while the branch of Dr. Johs. Schmidt within the commission had rooms at the Carlsberg Laboratory. The accomodations at Villa "Eltham" were not ideal, but down to the shore of the Sound there was a lovely garden, which was often used during the annual meetings of the International Council for the Exploration of the Sea (Fig. 59 and 60).

When Dr. Johs. Schmidt died in 1933, his branch —for which there was absolutely no room at "Eltham"—was removed to Vestre Boulevard in the city. It was evident, however, that this could only be a temporary measure, and as the rooms of Villa "Eltham" grew more and more insufficient, a building was searched for that would hold all 4 branches of the commission besides the office of the International Council and the Biological Station, but it proved to be very difficult to find the proper place. Various building plans were discussed, but still no result was achieved.

Fig. 62. "Havkatten" ("The Catfish"), the motor-boat of the Biological Station on coastal investigations. S. Fogh phot.

At last the attention was drawn to the Charlottenlund Castle. Since the death of Louise, the Mother-Queen, in 1926 this beautiful little castle in the lovely park had been unoccupied. It has about 40 rooms, excellently suited for working, meetings, etc.; below there is a large cellar with ample room for the keeping of collections, among which those from the circumnavigation of the "Dana" alone occupy several kms. of shelving. After the necessary restorations and modernizations had been carried out, *i. a.* the installation of central heating, the moving in took place in the autumn of 1936.

At the Charlottenlund Castle the Biological Station now has 10 large and light working rooms and laboratories besides cellarage for the collections. With the new research-vessel and the good working conditions ashore the Station now possesses an excellent instrument for its investigations.

THE LIBERATION OF SALMON AND TROUT FRY. DAB INVESTIGATIONS

The Report of the Biological Station for 1937, No. 42 in the series, contains 3 papers. C. V. Otterstrøm writes "On Methodical Liberations of Salmon and Trout Fry in Watercourses with Special Reference to the Gudenaa Area". The author lays down the demands to be made on streams in which tiny fry are liberated and, accordingly, groups the Danish watercourses within 4 categories; he proposes to liberate $^1/_2$, 1 and 2 pieces of fry per 1 m² according as the stream is usable, suitable or pre-eminently suited for liberations. On this basis he describes a plan worked up for liberations in the Gudenaa area. During recent years such plans of liberation have gradually been worked up by the Biological Station for most of the greater streams of this country, so that we now possess a methodical scheme in the work of restoring the stocks of salmon and trout in our fresh waters.

E. M. Poulsen writes about "The Dab in the Danish Waters, Investigations on Stock and Growth". After a mention of the variations in the catch yields and in the size and growth of the dab population it is shown that the minimum size of 25 cm that was introduced in 1934 has been of little importance as far as a rise of the prices is concerned, and that it will induce a marked increase of the dab population at the sacrifice of the stock of plaice.

In the third paper of Report 42 Aage J. C. Jensen discusses "The Races of Dab in the Danish Waters". No actual difference in the number of vertebrae can be established between the North Sea dab and the Baltic dab whereas the number of anal fin rays varies not only from one locality to another, but also from year to year within the same water. In the shape of growth and the time at which sexual maturity is attained there are also differences in various waters.

Also in 1938 investigations went on according to plan. The disease of the eel-grass was followed closely, but the hopes of a rapid recovery vanished away as it turned out that the new vegetations appearing here and there died after having attained a height of 20—30 cm. The vegetations roughly held their ground only near the outfalls of freshwater in the bottom of the fjords and in southern waters where the salinity is very low; in other words the spreading of the pathogene seems to be impeded by fresh and very brackish water. In the summer of 1938 a Dutch commission consisting of Dr. Havinga, Dr. Houber and Dr. Reigarsman visited the "Biologen" in order to study the spread of the disease in Danish waters. In Holland the vast vegetations, especially in the Zuyder Zee, are of great economic importance, and the devastations had carried along great losses to the fishermen collecting the eel-grass and to the industry utilizing it.—Other visitors onboard were Dr. Kändler and stud. mag. Vibe.

Fig. 63. "Danmarks Akvarium".

THE RACES OF PLAICE

Report No. 43, 1938, of the Biological Station contains a paper by E. M. Poulsen, "On the Migrations and the Racial Character of the Plaice". Working on the basis of an extensive statistic material, particularly countings of fin rays, the author demonstrates that the so-called "Baltic" race of plaice includes two different forms, a Belt Sea and a Baltic form, differing in number of both vertebrae and anal fin rays. In the North Sea and the Skagerak the variations in the number of vertebrae and anal fin rays of the plaice are so small, that here we have to do with one form or race only, the North Sea race or the Atlantic form, the habitat of which covers the whole of the North Sea from the Channel to Iceland and the Barent Sea. A change of the racial character of number of anal fin rays in the Belt Sea plaice arising from transplantations of North Sea plaice to the Belt Sea could not be established.

Fig. 64. The freshwater fisheries branch of the Biological Station at Frederiksdal on the Furesø. C. V. Otterstrøm phot.

1939. "DANMARKS AKVARIUM". THE WAR

In 1939, the 50th year in the history of the Biological Station, the investigations from the "Biologen" were carried on according to plan until the war broke out. In the spring of the same year "Danmarks Akvarium" was opened to the public. For the erection of this great, modern and very beautiful aquarium in the castle park of Charlottenlund, in the immediate vicinity of the castle, the "stronghold of marine investigations", we are principally indebted to Mr. K. Højgaard, Civ. Eng. His son, Mag. M. Højgaard is the daily leader, Mag. Mandahl-Barth acting as his assistant. In the management of the aquarium Prof. Martin Knudsen is chairman, the board of directors otherwise including such members as Mr. Trolle Thomsen, Superintendent of Fisheries, and Prof. Aug. Krogh. In the cellars of the building there has been arranged a division for fishery biology where a considerable number of tanks of different sizes may be used for scientific experiments. In this way a long-felt desideratum has been relieved. In return the fishery biologists of course endeavour to help the aquarium by procuring material for the public aquaria.

Of visitors onboard in 1939 the journal of the Biological Station mentions Mag. Højgaard and Mag. Mandahl-Barth, who collected material for the aquarium from the "Biologen". Other visitors were Mr. Heding, Ass., Dr. Steemann-Nielsen

and Mag. Heegaard. Among new investigations started was an examination of the quality of the herring at Bornholm in connexion with analyses of the stomach contents of the herring and of the plankton of the Baltic. These investigations were occasioned by complaints from the fishermen that the herring at Bornholm in 1939 were exceptionally lean. There proved to be some connexion between the quality of the herring and the plankton; the investigations are being continued in spite of the war.

Report No. 44 for the year 1939 contains a paper by C. V. Otterstrøm and E. Steemann-Nielsen, "Two Cases of Extensive Mortality in Fishes Caused by the Flagellate *Prymnesium parvum*, Carter." In two different brackish water lakes, one in Jutland, the other on Seeland, a catastrophe to the fish populations occurred in 1938 and 1939, respectively: all kinds of fishes died within a very short time. An examination showed that the water was filled with millions of *Prymnesium* (up to 1,200,000 individuals per 1 cm^3). Experiments showed that the flagellate itself is not poisonous: the fishes must have been killed by some matter contained in the water and most likely originating from the metabolism of the flagellate. The best method of providing against the evil in vast areas of water will undoubtedly be to make the water so fresh, that *Prymnesium* cannot survive.

On August 1st, 1939, the jubilee of the Station was celebrated under gathering clouds in the political sky exactly as when the semi-jubilee was celebrated in 1914. One month later the war broke out; the "Biologen" was laid up for good, and the investigations at sea came to an end. Though it has still been possible to carry on some of the principal investigations pursued for several years, for instance coastal investigations from "Havkatten", the motorboat of the Station, the surveying works during the transplantations and the investigations in the Limfjord, the Isefjord and at Bornholm by means of hired or borrowed material, it is evident that the war has put an end to many important investigations, the interruption of which is most regrettable. However, the principal task during the present situation of war is to follow the indubitably enormous effects of the war on the fish populations, so that, by the end of the war, we shall be ready to use such effective measures as will be able to protect the increased fish population that will no doubt arise on account of the very limited extent of fishing during the period of war. The Biological Station therefore carries out a great many examinations of samples from the catches of fishermen of different waters in order to follow the development of these conditions.

CONCLUDING REMARKS

I have used the pause made by the war in the cruises of the "Biologen" to take a retrospect of the history of the Biological Station through 50 years. From a small beginning the Station has risen to become a factor of importance, an institution the achievements of which are acknowledged everywhere, both abroad and among the Danish fishermen. Under the leadership of two distinguished men, Dr. C. G. Joh. Petersen and Dr. A. C. Johansen a pioneer work was carried out, the chief result of which is an intimate knowledge of the biology of our principal food fishes. Besides this the influence of the fisheries on the fish populations has been subjected to detailed studies; this question is still of vital and immediate importance in the ever increasing use of machine power in the service of the fisheries during modern times. It is unnecessary to emphasize the importance of orientating oneself in these matters, so that the most effective utilization of the stocks of fish can be achieved by means of an adequate fisheries legislation.

As will appear from the previous pages the results achieved by the Station have in many fields been of great value to the practical fishery. It will suffice to point to the large-scale transplantations of plaice from the North Sea to the Limfjord and the Belt Sea, from which a considerable annual income falls to the fishermen. In addition, and this I want to stress, the mutual influence during the work of the Station among the fishermen has gradually brought about a contact between the fishermen and the biologists, so that the previous mistrust of the former in the biologists has now disappeared and been superseded by confidence and collaboration. Representatives of the Biological Station are now regularly invited to the general assemblies of the fishermen,

where they get an opportunity of exchanging thoughts and ideas with the fishermen and of answering questions. It remains to be said that throughout the year the Station naturally acts as an adviser of fishermen and other persons interested in questions concerning both salt water and freshwater fisheries.

It has been my goal as director of the Biological Station to carry on and to extend the work that was initiated by my distinguished predecessors. The Station now has at its disposal a staff of good collaborators and an excellent material, and it is my hope that we shall soon be able to resume our investigations in their full extent. I further trust that the international explorations of the sea will safely survive this war as they did the last one, so that the collaboration with the foreign fishery biologists may be fully revived as soon as the war is over. For only an international collaboration can positively protect the fish populations of the open Danish waters against the dangerous effects of the ever increasing fisheries. So this will be the first problem of after-war times.

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